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# FISHES AND MACROINVERTEBRATES OF THE WHITE AND YAMPA RIVERS

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NUMBER ONE
BIOLOGICAL SCIENCES SERIES
Bureau of Land Management • Colorado

IN REPLY REFER TO

CO-933
4251.5

# United States Department of the Interior

BUREAU OF LAND MANAGEMENT
COLORADO STATE OFFICE
ROOM 700, COLORADO STATE BANK BUILDING
1600 BROADWAY
DENVER, COLORADO 80202

January 17, 1980

Dear Friend:

As you may know, the energy and mineral resources in northwest Colorado are an important national asset. In the next few years, the development of these resources may have significant impacts on the natural environment of this area. In 1975, The Bureau of Land Management, which is responsible for the administration and leasing of large areas of this resource land, undertook a three year program for the purpose of identifying aquatic resource values which will be impacted by energy and mineral development in this area. The work was done under contract with Colorado State University, Department of Fishery and Wildlife Biology, Fort Collins, Colorado. We expect the information obtained in this baseline inventory will be useful to anyone who is involved in the conservation, development and utilization of natural resources of northwest Colorado. It is for that reason that we are sending you a copy of final report of the work done under this contract.

Sincerely yours,

DALE R. ANDRUS
State Director

Enclosure

# FISHES AND MACROINVERTEBRATES OF THE WHITE AND YAMPA RIVERS, COLORADO

Final Report on a Baseline Survey

Conducted for

The Bureau of Land Management

by

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February, 1979

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# PREFACE

In July, 1975, the Bureau of Land Management contracted with Colorado State University for a baseline survey of the fishes and aquatic macroinvertebrates of selected reaches of the White and Yampa Rivers in Colorado. This survey was proposed to compliment work done by the Colorado Division of Wildlife and other resource agencies prior to the onset of coal strip-mining activities in northwestern Colorado. General objectives of the study were to gather quantitative data on 1) distribution, abundance and diversity of fish and macroinvertebrate communities of the two streams; 2) age, growth, condition, and food habits of common fishes; and 3) quality of habitat for fish and macroinvertebrate communities. Specific studies varied widely within this general framework. Work on fishes was restricted on the Yampa River to the portion between Hayden, Colorado, and the Lily Park Pool area, 3 to 4 km west of Cross Mountain Canyon, and on the White River to an area between Rio Blanco Lake and Spring Creek. Macroinvertebrates were collected from Steamboat Springs, Colorado, to Cross Mountain on the Yampa and from Meeker to Rangely, Colorado, on the White River.

Two Graduate Research Assistants, Charles G. Prewitt and Elizabeth L. Ames, began field work in July of 1975. In 1976, Graduate Assistants Darrel E. Snyder and Edmund J. Wick joined the study team. Ms. Ames conducted a 2-year study of the aquatic macroinvertebrates of the Yampa and White Rivers. Mr. Prewitt's and Mr. Wick's work was concentrated on fishes (particularly catostomids) and physical-chemical characteristics (fish habitat) of the two streams. Mr. Snyder's work and some of Mr. Wick's work emphasized the larval and early juvenile fishes of the two rivers. All of these individuals and their supervising professors (Clarence A. Carlson and W. Don Fronk) have contributed to this final project report.

This paper reports 3 years and 5 months of research on the White and Yampa Rivers. We have attempted to summarize all project work except that which has or will be presented in theses. Progress reports have been prepared twice each year (in June and January) since preparation of our initial progress report in December 1975. Copies of these reports, which contain some details not presented here, are available from the senior author. In some instances, this report corrects or refines information in the progress reports. We have chosen to avoid constant reference to these documents in preparation of this final report.

## INTRODUCTION

Robert Rush Miller (1946) called for ichthyological surveys of major rivers of western North America, including those in the Colorado River Basin. He cited an urgent need for such surveys ". . . because of changes caused by: (1) effects of dams and diversions, water-power development, water storage, and irrigation practices; (2) pollution from mining operations; . . . and (4) introduction of exotic species." For many tributaries of the upper Colorado River, the need for complete and rigorous surveys for the same reasons is as real today as in 1946. Crawford and Peterson (1974) considered the Colorado River to be the most utilized, controlled and disputed river in the world. Bishop and Porcella (1976) characterized the Colorado River as "highly developed and totally regulated." They further stated that "In viewing any future energy development in the basin, certainly a major effort is needed in understanding the effects of land and water use for energy development on quality and quantity of river flow, and the life-sustaining requirements of animal species."

Miller (1959) reported that 74% of the Colorado River System fishes were endemic. Today, the upper and middle basins are the only refuges for the remaining large-river fishes (Holden and Stalnaker 1975a and b). Consumptive use of Yampa River water is expected to triple between 1976 and 1985 (Steele 1975), and major Yampa River impoundments at Juniper Springs and Cross Mountain Canyons have been proposed. Even greater depletions of the waters of the White River are expected as a result of oil shale processing. Potential effects of these changes on aquatic biota must be evaluated.

Athearn (1977) described the history of human occupation and use of the area containing the White and Yampa Rivers. Studies of the streams themselves were limited before current interest in endangered species and energy development in northwestern Colorado. To place our study in historical and scientific perspective, a roughly chronological summary of available information on the White and Yampa Rivers, with emphasis on aquatic biota (and particularly fishes), follows.

White River

Most of the earlier work on the river was conducted for sport-fish management purposes. Feast (1938), in a paper on the feasibility of transplanting whitefish from the White River to the Roaring Fork and Eagle Rivers, described the White River and its drainage basin. The "fish environment," with an abundance of mountain whitefish (Prosopium williamsoni), and the food grade of the White River were reported as excellent. Feast concluded that whitefish should not be transplanted as proposed. Hess and Klein (1947) included the White River in a group of rivers censused in

1945 and 1946; increased stocking and other management were generally recommended. Klein (1952) discussed returns of tagged rainbow trout (Salmo gairdneri) released to the White River in 1947. Lemons (1955) reported that channel catfish (Ictalurus punctatus) were found only in the lower 32 km of the White River and that the best fishing for that species was from Rangely to the state line. Lynch and Lemons (1956) mentioned a few channel catfish collected from the White River in their summary of age, growth and weight data for that species. The salmonid populations in the White River drainage above Piceance Creek were inventoried during the summer of 1955 by Klein (1957) as a preliminary step in evaluating whitefish management in Colorado. Mountain whitefish, rainbow trout, brook trout (Salvelinus fontinalis), brown trout (Salmo trutta), cutthroat trout (Salmo clarki), speckled dace (Rhinichthys osculus), flannelmouth suckers (Catostomus latipinnis), and bluehead suckers (C. discobolus) were collected.

A survey of the White River above Rio Blanco Lake was conducted from 1962 to 1965 by Hill and Burkhard to determine the impact of water developments by the Rocky Mountain Power Company and the Yellow Jacket Unit of the Bureau of Reclamation's White-Yampa Project. Hill (1964) reported on physical characteristics, fishes, and macroinvertebrates of the South Fork of the White River. Rainbow trout were the most abundant fishes, but brook trout, brown trout, cutthroat trout, and sculpins (Cottus) were also collected by electrofishing. The aquatic insect orders Diptera (true flies), Trichoptera (caddisflies), Ephemeroptera (mayflies) and Plecoptera (stoneflies) made up 95% of the total number and volume of benthic organisms collected from the South Fork and Sweetwater Creek. Hill (1965) reported on habitat at various discharge levels, water chemistry, fish populations, and benthos in the same streams and the North Fork and "main" White River. Electrofishing on the South Fork and Sweetwater Creek disclosed "no change in species composition" since his 1964 report. Rainbow trout were predominant (cutthroat were common and some brook trout present) in the upper North Fork. Whitefish made up most of the catch from the middle and lower North Fork stations (one rainbow trout was taken in the middle section). Sculpins were also collected at all North Fork stations. In the White River, which was said to be very difficult to sample by electrofishing because of its depth and width, only "suckers" were collected. In bottom samples from the North and South Forks, mayflies, stoneflies and true flies dominated numbers and volume. Hill and Burkhard (1967) expanded on the South Fork and Sweetwater Creek data and estimated optimum stream flows at sampling stations.

May's (1970) thesis on the biotia and chemistry of Piceance Creek included reference to samples collected in 1968 and 1969 a three stations on the White River near the mouth of Piceance Creek within our study area; Everhart and May (1973) summarized the same data. Water temperature, discharge, specific conductance, dissolved oxygen, total alkalinity, pH, filterable solids, major cations and anions, trace elements, and benthic invertebrates were determined at each station. Fish species diversity of the White River was slightly higher than that of Piceance Creek. Flannelmouth sucker, mountain sucker (Catostomus platyrhynchus), mottled sculpin (Cottus bairdi), roundtail chub (Gila robusta), black bullhead (Ictalurus melas), channel catfish, red shiner (Notropis lutrensis), Colorado squawfish (Ptychocheilus lucius), speckled dace, brown trout, and rainbow trout were collected from the White River. Everhart and May (1973) reported Gila elegans (which now refers to the bonytail) instead of *G. robusta* (as in May's 1970 thesis); this was probably an error in transcription or the result of some taxonomic confusion. Aquatic invertebrates reported from the White River included mayflies, true flies, caddisflies, stoneflies, beetles (Coleoptera), dragonflies and damselflies (Odonata), oligochaete worms (Plesiopora), amphipod crustaceans, pulmonate snails and leeches identified to family or genus. Specific collection sites and numbers of specimens were not included.

Studies coordinated by Thorne Ecological Institute and conducted in the Piceance Creek Basin (Regional Oil Shale Study) included peripheral reference to the White River near Piceance and/or Yellow Creeks. Pennak (1974) reported on summer limnological conditions. True flies, mayflies, caddisflies and stoneflies were found at all stations and were identified to genus. Benthic animal productivity was generally low. Organic lithophyton productivity was unusually high. Wilbur (1973 and 1974) presented data on temperature, pH, dissolved oxygen, elemental concentrations, chloride, hardness, nitrate, phosphate, fluoride, and conductivity. Pettus (1973 and 1974) collected fishes from White River stations by electrofishing, angling, and seines. Fishes collected from White River were mottled sculpin, speckled dace, mountain whitefish, carp (*Cyprinus carpio*), flannelmouth sucker, bluehead sucker, rainbow trout, brown trout and fathead minnow (*Pimephales promelas*). White suckers (*Catostomus commersoni*) were also reported from the White River and Piceance Creek, but they have not been found in these streams by any other investigator.

In 1974, the consulting firm of Woodward-Envicon began studies reported to the Area Oil Shale Supervisor of the U.S. Geological Survey (Ashland Oil, Inc. and Shell Oil Co. 1975-76) on findings related to the

Colorado Oil Shale Lease Tract C-b Environmental and Exploration Program. Although their aquatic studies were concentrated on Piceance, Willow and Stewart Creeks, two White River stations were also sampled. Fish, benthic invertebrate, periphyton production, sediment and aquatic microbiology results were presented. In 1974, flannelmouth suckers, mottled sculpins and speckled dace were collected from the White River stations by electrofishing. In 1975, mountain whitefish were added to the list of fish species collected. No additional fish species were collected in 1976. Benthic invertebrates collected in Tract C-b were identified to various taxonomic levels without mention of their specific collection sites.

Similar reports on Colorado Oil Shale Lease Tract C-a (Gulf Oil Corp. and Standard Oil Co. 1975-77), were based on data collected by NUS Corporation. Fifteen stations were established on the White River near the mouth of Piceance Creek. Physical and chemical conditions, phytoplankton, zooplankton, periphyton, primary production, benthos, macrophytes, fish, sediment chemistry, rare and endangered species, springs and seepages, and water quality were routinely studied. Macroinvertebrates collected for the Rio Blanco Oil Shale Project (related to Tract C-a) were identified to various taxonomic levels (commonly genus) without specific reference to sites of collection. Oligochaetes, Chironomidae, Simuliidae, Hydropsychidae, Tricorythidae, Baetidae, Ephemerellidae, and stoneflies were reported as most common at White River stations on various dates. Fish collected by electrofishing and dipnetting in late 1974 were rainbow trout, brown trout, mountain whitefish, fathead minnow, longnose dace (<u>Rhinichthys cataractae</u>), speckled dace, bluehead sucker, flannelmouth sucker and mottled sculpin. Roundtail chub, bluehead x flannelmouth sucker hybrids, cutthroat trout, carp, red shiner, mountain sucker (Catostomus platyrhynchus), black bullhead and channel catfish were added to the list of fishes collected from the same locations in 1975. Fishes most frequently collected were suckers, dace, fathead minnows, and mottled sculpins. In July-August, 1975, no fishes were collected from Yellow Creek; reported from the White River alone were 109 flannelmouth sucker, 32 speckled dace, 15 bluehead sucker, 10 mottled sculpin, 5 roundtail chub, 2 carp, 1 black bullhead and 1 red shiner. In October and November, 1975, 98 mottled sculpins, 70 speckled dace, 9 mountain whitefish, 8 bluehead suckers, 4 flannelmouth suckers, 1 flannelmouth x bluehead hybrid, 1 brown trout, 1 roundtail chub, 1 fathead minnow and 1 channel catfish were collected from the White River. Fish sampling continued through 1976, but no additional species were found. During July-August, 1976, collections were again restricted to the White River; 180 flannelmouth sucker, 163 speckled dace, 75 mottled sculpins, 39 bluehead suckers, 5 fathead minnows, 1 roundtail chub and 1 carp were taken.

Goettl and Edde (1978) collected fishes at several stations on Piceance Creek in 1975 and 1976; they summarized previous fish studies on Piceance Creek but did not sample the White River.

Our studies began in July 1975 and have thus far resulted in two masters theses (with two more underway) and our unpublished semi-annual progress reports. Ames (1977) reported on aquatic insects at four sites on the White River between Meeker and Rangely collected from July 1975 to September 1976. Species diversity values were determined for all White River sampling sites. Species composition and abundance were correlated with longitudinal changes in stream substrate and other physical characteristics. Significant variance between sampling sites on the White River was noted. Details are presented later in this report. Distribution and numbers of selected mayfly species were emphasized. Prewitt (1977) analyzed distribution, meristics, morphometrics, and isoenzymes of the catostomid fishes of the White River. Neither white suckers nor their hybrids with native suckers occurred in the White River. Flannelmouth and bluehead suckers were common at all stations on the White River; flannelmouth x bluehead hybrids were rare. Hybrid suckers were considered nonreproductive. Prewitt, Wick and Snyder (1978) discussed populations and habitat of humpback chubs and Colorado squawfish in a White River reach which corresponded to part of our fish collection area and extended from Rio Blanco Lake to the County Road 65 bridge in Rio Blanco County. Their 1977 collections at eight stations on the White River are summarized in Table 1.

McKean and Burkhard (1978) described the aquatic resources in the area of the Yellow Jacket Project, a flow-regulation project involving the North Fork and several other tributaries of the White River. Field research was concentrated on the White River and its tributaries above Meeker. The history of the fishery and recreational use of fishery resources were considered. Fish populations were inventoried by electrofishing in 1975 and 1976. Fishes encountered in the White River drainage were mountain whitefish, rainbow trout, cutthroat trout, rainbow x cutthroat hybrids, brown trout, brook trout, bluehead sucker, mountain sucker, flannelmouth sucker, mottled sculpin, speckled dace, roundtail chub and redside shiner (<u>Richardsonius balteatus</u>). The latter unexpected species may have been related to the erroneous report of redside shiners in the White River in our December, 1975, progress report. Other species reported in our progress reports and by May (1970) were added to their list of species present. It

Table 1. Total numbers and percentage composition of fishes collected at each trend zone sampling site (all habitats combined) in the White River between Rio Blanco Lake and County Road 65 Bridge, Colorado, 31 July through 2 August 1977. From Prewitt, Wick and Snyder (1978).

| Collection Site: | A | | B | | C | | D | | E | | F | | G | | H | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date (day): | 1 | | 1 | | 31/2 | | 1 | | 2 | | 1 | | 1 | | 2 | |
| Time: | 11-12 AM | | 1-2 PM | | 6-7 PM / 9-10 AM | | 2-3 PM | | 11-12 AM | | 4-5 PM | | 6-7 PM | | 1-3 PM | |
| Water Temperature (C): | 18-23 | | 19 | | 21/16-17 | | 19-21 | | 18-22 | | 24-30 | | 24 | | 22 | |
| Habitats Sampled:[a] | acf | | acf | | abcf | | ace | | abc | | abce | | acef | | abcef | |
| Length Group (mm TL):[b] | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 |
| Total Fish Collected: | 238 | 927 | 34 | 85 | 15 | 302 | 6 | 354 | 35 | 261 | 37 | 248 | - | 240 | 19 | 263 |
| % Composition:[c] | | | | | | | | | | | | | | | | |
| *Prosopium williamsoni* | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Cyprinus carpio* | - | - | - | 1 | - | 7 | - | * | - | - | - | 4 | - | 5 | - | - |
| *Gila robusta* | 7 | 6 | 21 | 12 | 47 | 20 | 50 | 43 | - | 10 | 5 | 30 | - | 23 | 16 | 40 |
| *Notropis lutrensis* | - | - | - | 19 | - | 1 | - | 5 | - | 1 | - | 29 | - | 25 | - | 3 |
| *Pimephales promelas* | 3 | 2 | - | 4 | - | 4 | - | 8 | - | * | 14 | 4 | - | 2 | 5 | 1 |
| *Rhinichthys osculus* | 85 | 69 | 74 | 21 | 53 | 43 | 50 | 22 | 100 | 77 | 78 | 22 | - | 27 | 79 | 40 |
| *Catostomus discobolus* | 5 | 16 | 6 | 12 | - | 7 | - | 5 | - | 1 | - | 3 | - | 1 | - | 3 |
| *Catostomus latipinnis* | - | 6 | - | 29 | - | 18 | - | 17 | - | 11 | 3 | 8 | - | 15 | - | 14 |
| *Ictalurus punctatus* | - | - | - | - | - | - | - | - | - | * | - | - | - | - | - | - |
| *Cottus bairdi* | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - |

[a] Key to generalized habitat types: a- backwater, b- pool, c- shoreline, d- chute channel, e-riffle, f- run.

[b] Larvae and juveniles less than or equal to 20 mm TL (≤20) were probably spawned within about 5 weeks of the date of collection. Specimens greater than 20 mm TL (>20) include older larvae and young-of-the-year juveniles as well as older juveniles and adults.

[c] * = <0.5%; - = no specimens collected.

should be noted that our "unverified" report of collection of the beautiful shiner (Notropis formosus) in 1976 was subsequently found to be due to collection of an aberrant specimen of the red shiner (N. lutrensis). Relative numbers of fish collected were comparable to the results of collections by Hill (1964) and Klein (1957). Length and weight data from specimens collected by electrofishing and observed during creel census were also presented. Limited aquatic invertebrate data collected in 1976 from the North Fork, South Fork and main White River were also presented. Flows necessary to preserve existing fisheries were estimated.

The status of endangered fish species which are known to or may inhabit the White River have been discussed by several authors, including Behnke (1973a, b, and c), Kidd (1975), Johnson (1976), Langlois (1977), Seethaler, McAda and Wydoski (1977) and Seethaler (1978). A recovery plan has been developed for the Colorado squawfish (Colorado Fishes Recovery Team 1978), and a draft recovery plan for the humpback chub is available.

Olsen (1973) and Wilson (1973) presented very limited data on biota of the White River in Utah. Baumann and Winget (1975), in an environmental evaluation of proposed oil shale development in Uintah County, Utah, summarized Utah Division of Wildlife Resources fish data collected in 1974 and 1975 at eight stations on the White River by means of electrofishing and explosives. Eleven species were collected; red shiners, speckled dace, and flannelmouth suckers were most common. Other species reported were fathead minnow, carp, roundtail chub, bluehead sucker, channel catfish, black bullhead, brown trout and smallmouth bass (Micropterus *dolomieui*). No rare species were collected. Water quality and macroinvertebrates were also described. Data on physical and chemical parameters, benthic flora and fauna, and fishes were presented by the Utah Wildlife Resources Division (1977) in their input to the White River Environmental Impact Statement. A report on a BLM-sponsored study of endemic fishes in the White River in Utah is in preparation by S. Lanigan, C. Berry and D. Robinson of Utah State University.

Physical and chemical data on the White River are available primarily from four sources. U.S. Geological Survey data on discharge, sediment and temperature from permanent and temporary gaging stations in the upper Colorado River basin were compiled by Iorns, Hembree, Phoenix and Oakland (1964) and Iorns, Hembree and Oakland (1965). A report of the Colorado Water Conservation Board (1966) summarized data on the water resources of the White River basin in Colorado, and water quality in the White River in Colorado was determined by the Environmental Protection Agency (1977).

A summary of fish species reported in the literature on the White River in Colorado and Utah is presented in Table 2. Invertebrate, physical and chemical data were considered too detailed to conveniently summarize in a similar manner.

## Yampa River

The Yampa River, which served as Powell's route to the Green River on his first expedition to the Colorado River in 1869 (Howard 1978), is one of the major rivers in northern Colorado. As on the White River, much of the early work on this river was conducted to facilitate sport-fish management. Feast (1938) described the Yampa River drainage and discussed its whitefish population very briefly. Klein (1952) briefly mentioned

Table 2. Summary of fishes reported from the White River in Colorado and Utah.

| Species | Upper drainage Klein (1957) | Lower Lemons (1955) | S. Fork Hill (1964) | Everhart & May (1973) | Pettus (1973 & 1974b) | Ashland & Shell Oil (1975-1976) | Gulf & Standard (1975-1977) | Prewitt et al. (1978) | Utah Div. Wildlife Res. (1974-1975) | McKean & Burkhard (1978) |
|---|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | X | | X | X | X | X | (X)* | X | | X |
| *Salmo trutta* | X | | X | X | X | | (X) | | X | X |
| *S. gairdneri* | X | | X | X | X | | X | | | X |
| *S. clarki* | X | | X | | | | X | | | X |
| *Salvelinus fontinalis* | X | | X | | | | | | | X |
| *Cyprinus carpio* | | | | | X | | (X) | X | X | |
| *Gila robusta* | X | | | X | | | (X) | X | X | X |
| *Notropis lutrensis* | | | | X | | | (X) | X | X | |
| *Pimephales promelas* | | | | | X | | (X) | X | X | |
| *Ptychocheilus lucius* | | | | X | | | | | | |
| *Rhinichthys osculus* | X | | | X | X | X | (X) | X | X | X |
| *R. cataractae* | | | | | | | X | | | |
| *Richardsonius balteatus* | | | | | | | | | | X |
| *Catostomus commersoni* | | | | | X(?) | | | | | |
| *C. discobolus* | X | | | | X | | (X) | X | X | X |
| *C. latipinnis* | X | | | X | X | X | (X) | X | X | X |
| *C. discobolus* x *latipinnis* | | | | | | | (X) | | | |
| *C. platyrhynchus* | | | | X | | | X | | | X |
| *Ictalurus melas* | | | | X | | | (X) | | X | |
| *I. melas* | | X | | X | | | (X) | X | X | |
| *Cottus bairdi* | X | | X | X | X | X | (X) | X | | X |
| *Micropterus dolomieui* | | | | | | | | | X | |

*Circled from White River

returns of tagged rainbow trout released to the Yampa River at Steamboat Springs. Very limited work led Lemons (1954) to conclude that channel catfish should be reared in the "Maybell pond" for introduction to the Yampa River. Lemons (1955) described fishing in the Yampa as primarily for trout above Craig and for channel catfish below Maybell, with temperatures, "silt", and high water limiting "both types of fishing between these towns." Channel catfish, bonnytail (sic) and squawfish were reported from "every hole that was fished" on a float trip in June 1955 from Lily Park to Pat's Hole. Klein (1957) censused the Yampa River upstream from Hayden in the summer of 1955; whitefish were declared approximately four times as abundant and trout about half as abundant in the Yampa as in the White River on a stream footage basis. Rainbow, brook, brown and "native" trout were reported from both drainages. A few fish from the Yampa River were mentioned in the growth studies of Lynch and Lemons (1956) and Lynch (1957).

The lower Yampa River (from Hayden, Colorado, to the confluence with the Green River) was studied by Baily and Alberti (1952); fishes, benthos, physical features, and fish habitat were described. The stream was characterized as slow-flowing, with low average gradient and sparse streamside vegetation; river temperatures were high during the summer, and turbidity was high after heavy rains. Bottom samples from four stations were dominated by mayflies, caddisflies and true flies at all stations. Benthic production was low at the lower stations (Lily Park and Pat's Hole). Fishes were collected by electrofishing (Hayden to Craig) and gill and fyke nets (Craig to Lily Park). Speckled dace, flannelmouth suckers, and mottled sculpins were listed as numerous; bluehead suckers and mountain whitefish were listed as common. Colorado squawfish were considered common from Hayden to the Green River, but since roundtail chubs were not listed among the collected fishes, an erroneous identification is suspected. Few carp, channel catfish, rainbow trout and brown trout were collected. Creek chubs (Semotilus atromaculatus), black bullheads, cutthroat trout and green sunfish (Lepomis cyanellus) were rarely collected.

Banks (1964) surveyed fish distribution within Dinosaur National Monument in 1961 and 1962; virtually the same data were preliminarily summarized by Hagen and Banks (1963). Yampa River data (from Echo Park and Castle Park sites) showed speckled dace, bonytail (and/or humpback and roundtail?) chubs and flannelmouth suckers were most frequently collected. Redside shiners, fathead minnows, bluehead suckers, channel catfish, mottled sculpins, carp, Colorado squawfish, and green sunfish were also collected. Stream flow, temperature and turbidity were considered influences upon fish distribution in the Yampa and Green Rivers. Habitats in which various fishes were caught and fish food habits were also discussed by Banks (1964).

Holden's work on fishes of the upper Colorado River basin led to clarification of species of cyprinids of the chub genus Gila (Holden and Stalnaker 1970). Suttkus and Clemmer (1977) subsequently redefined Gila cypha (humpback chub) from specimens collected in Grand Canyon and discussed differences between that species and G. robusta (roundtail chub) and G. elegans (bonytail).

In 1975, Holden and Stalnaker published two reports on fish distribution which pertained, in part, to the Yampa River. Holden and Stalnaker (1975a) studied fishes of the Yampa River as part of a 1968 to 1973 study at an upper station from Craig to Juniper Springs, Colorado, and a lower one in Yampa Canyon in Dinosaur National Park. Table 3 provides a summary of the relative abundance of the fishes they collected, with identification of species native to the upper Colorado River basin. Distribution, trends in abundance, and historical background of each species were discussed. Habitat preferences and reproductive success were discussed for selected species as were reasons for declines of native species. Using much of the same data, Holden and Stalnaker (1975b) reported on fish collected by electrofishing, gill nets, and seines from Craig to the mouth of the Yampa River between 1968 and 1971. Relative abundance of fishes collected at specific sites is included in Table 3. Squawfish collections were related to water temperature and turbidity; squawfish seemed to move into the Yampa River from the Green River as waters cleared and warmed in July and August, presumably to spawn. The walleye (Stizostedion vitreum), bluegills (Lepomis macrochirus), and largemouth bass (Micropterus salmoides) collected were considered "wanderers" from reservoirs on the upper Green River system. Red shiners, creek chubs, mottled sculpins and hybrid suckers reported from the Yampa by Holden and Stalnaker in their 1975a paper were not reported in their 1975b paper. Kidd's (1975) Table II on the Yampa River is apparently from Holden's (1973) doctoral dissertation, and his data were essentially those reported by Holden and Stalnaker.

The Final Environmental Impact Statement on the Yampa Project (U.S. Dept. of Agriculture, Rural Electrification Administration 1974) contained information on the discharge patterns of the Yampa River near Maybell, quality of Yampa River water, and benthic fauna and fishes collected near Craig. Bottom fauna was dominated in weight and numbers by immature insects; mayflies and caddisflies were most abundant. Immature stoneflies, true flies

Table 3. Distribution and abundance of fishes collected from the Yampa River by Holden and Stalnaker (1975a and 1975b). (A = abundant, C = common, R = rare, S = scarce, O = occasional, * = native)

| Species | 1975a Upper Yampa | 1975a Lower Yampa | 1975b Craig | 1975b Juniper Springs | 1975b Little Snake | 1975b Upper Yampa Canyon | 1975b Lower Yampa Canyon |
|---|---|---|---|---|---|---|---|
| Salmo gairdneri | O | O | C | S | - | - | S |
| S. trutta | O | O | - | - | - | - | S |
| S. clarki | - | O | - | - | - | - | S |
| Prosopium williamsoni* | A | O | C | S | - | - | S |
| Cyprinus carpio | C | C | - | C | - | S | C |
| Gila robusta* | A | A | C | C | A | A | A |
| G. elegans* | - | R | - | - | - | - | S |
| G. cypha complex* | - | R | - | - | - | - | S |
| Ptychocheilus lucius* | R | R | - | S | - | S | S-C |
| Rhinichthys osculus* | C | A | C | C | A | A | A |
| Richardsonius balteatus* | C | A | C | C | A | A | A |
| Pimephales promelas | C | C | - | C | C | C | C |
| Notropis lutrensis | - | R | | | | | |
| Semotilus atromaculatus | - | C | | | | | |
| Catostomus latipinnis* | C | A | A | A | A | A | A |
| C. discobolus* | A | A | A | A | C | A | A |
| C. commersoni | A | R | A | C | - | S | S |
| Xyrauchen texanus* | - | R | - | - | - | S | S |
| Ictalurus punctatus | R | A | - | S | - | A | A |
| I. melas | - | R | - | - | - | - | S |
| Micropterus salmoides | - | O | - | - | - | - | S |
| Lepomis macrochirus | - | O | - | - | - | - | S |
| L. cyanellus | - | R | - | - | - | - | S |
| Stizostedion vitreum | - | O | - | - | - | - | S |
| Cottus bairdi* | - | R | | | | | |
| Catostomus latipinnis x X. texanus | - | R | | | | | |
| C. discobolus x C. commersoni | A | R | | | | | |
| C. latipinnis x C. commersoni | R-C | R | | | | | |

and beetles were less abundant. Fishes collected in 1971 and 1972, in decreasing order of numerical abundance, were speckled dace, mottled sculpin, redside shiner, mountain whitefish, bluehead sucker, white sucker, flannelmouth sucker, rainbow trout and roundtail chub.

Seethaler, McAda and Wydoski (1976), in a report on endangered and threatened fishes of the Yampa and Green Rivers in Dinosaur National Monument from 1974 to 1976, compared their collections to Holden's from the lower Yampa River. Their observations were similar to Holden's, but they did not collect bonytail chub, largemouth bass, bluegill, green sunfish, or walleye. Species in their collections from the lower Yampa which were not collected there by Holden were *Fundulus kansae* (plains killifish), *Gila atraria* (Utah chub), and *Notropis stramineus* (sand shiner). Colorado squawfish were said to ascend the Yampa River when water levels were high and additional food and habitat were available. Squawfish reproduction was said to have declined since the 1960's. Ripe humpback suckers (*Xyrauchen texanus*), also known as razorback suckers, of both sexes were reported on two spawning bars in the Yampa River. Evidence of increased hybridization between flannelmouth and humpback suckers was also reported. Six humpback chubs were collected from the lower Yampa River in 1975 and 1976. The Yampa River was mentioned as a possible refuge for some of the large-river endemic fishes that are threatened or endangered. The major contribution of the Yampa to continued survival of these fishes was considered to be its effect on the Green River below the confluence of the two streams, and Seethaler et al. (1976) stated that "Our concern is that any alteration of the Yampa River or its tributaries could have a serious negative impact upon this ameliorating effect."

Studies related to this project began in 1975 and have resulted in the Ames and Prewitt theses mentioned above. Ames (1977) studied aquatic insects at six stations on the Yampa River from Steamboat Springs to Cross Mountain (a distance of 177 km) in 1975 and 1976. Insects were collected by use of a kick net and were identified to genus or species. Mayflies and caddisflies were most abundant at all sites, and total mean abundance was greatest near Hayden. Significant variation was found between numbers of organisms collected at various sites and on various dates from the Yampa River. Diversity indices showed the Yampa to be a generally-clean river. As on the White River, ecology of certain mayfly species was emphasized. Prewitt (1977) analyzed catostomid fish samples collected from July 1975 through October 1976. Pure and hybrid suckers were identified by morphometric, meristic, electrophoretic and discriminant-function methods. Caudal peduncle depth/body length ratios of bluehead suckers decreased in downstream progression on the Yampa River. Bluehead x white and flannelmouth x white sucker hybrids were common in the Yampa; flannelmouth x bluehead hybrids were rare, supporting theories of reproductive isolation among sympatric species. Abundance of hybrid suckers in the upper Yampa River was believed due to the presence of the introduced white sucker and recent environmental disturbances.

Prewitt, Wick and Snyder (1978) reported on fish collection by seine, dipnet, and electrofishing at eight stations between Maybell and Sunbeam, Colorado, in 1977 (Table 4). Yampa River collections were much more diverse but contained a lower percentage of native species than did collections from the White River.

Questionable data on the fish populations of the Yampa River were contained in the Final Environmental Statement on Colorado Coal (U.S.

Table 4. Total numbers and percentage composition of fishes collected at each trend zone sampling site (all habitats combined) in the Yampa River between Maybell and Sunbeam, Colorado, 27 through 31 July 1977. From Prewitt, Wick and Snyder (1978).

| Collection Site: | A | | B | | C | | D | | E | | F | | G | | H | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date (day): | 27/28 | | 28 | | 28 | | 30 | | 30 | | 30 | | 30 | | 31 | |
| Time: | 10-12 PM / 8-12 AM | | 2-3 PM | | 4-5 PM | | 10-12 AM | | 1-2 PM | | 3-4 PM | | 5-6 PM | | 10-12 AM | |
| Water Temperature (C): | 21 | | 25-32 | | 24-27 | | 22-23 | | 23-27 | | 25-26 | | 26 | | 20-23 | |
| Habitats Sampled:[a] | abcef | | acde | | bcd | | acf | | ace | | acf | | ace | | abce | |
| Length Group (mm TL):[b] | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 | ≤20 | >20 |
| Total Fish Collected: | 643 | 968 | 185 | 606 | 362 | 555 | 100 | 821 | 322 | 287 | 457 | 519 | 10 | 303 | 47 | 331 |
| % Composition:[c] | | | | | | | | | | | | | | | | |
| Prosopium williamsoni | - | - | - | - | - | - | - | * | - | - | - | - | - | - | - | - |
| Cyprinus carpio | * | 18 | 1 | 14 | - | 23 | 3 | 2 | - | 9 | 1 | 15 | - | 1 | - | 4 |
| Gila robusta | 1 | 8 | 5 | 22 | 1 | 6 | 4 | 15 | - | 2 | * | 6 | - | 2 | - | 8 |
| Notropis stramineus | 14 | 27 | 34 | 8 | - | * | 5 | 10 | 10 | 1 | * | 1 | - | 3 | - | - |
| Pimephales promelas | 68 | 13 | 44 | 9 | 74 | 4 | 45 | 2 | 81 | 16 | 96 | 1 | 20 | - | 40 | 2 |
| Rhinichthys osculus | 10 | 15 | 10 | 9 | 7 | 42 | 21 | 16 | 2 | 30 | 1 | 16 | 70 | 41 | 32 | 27 |
| Richardsonius balteatus | 5 | 3 | 1 | 3 | 16 | 17 | 21 | 8 | 4 | 5 | 1 | 4 | - | 1 | 2 | 6 |
| R. balteatus X R. osculus? | - | - | - | - | - | - | - | * | - | - | - | - | - | - | - | - |
| Catostomus commersoni | - | * | - | * | - | 1 | - | 2 | - | 1 | - | 4 | - | 1 | - | 1 |
| C. discobolus | * | 4 | 1 | 14 | 1 | * | 1 | 6 | 3 | 25 | - | 7 | 10 | 1 | 2 | 6 |
| C. latipinnis | * | 11 | - | 19 | - | 6 | - | 34 | - | 10 | - | 43 | - | 50 | - | 38 |
| C. commersoni X discobolus[d] | - | * | - | 1 | - | - | - | * | - | - | - | - | - | - | - | - |
| C. commersoni X latipinnis[d] | - | 1 | - | - | - | - | - | 1 | - | - | - | 3 | - | - | - | - |
| Catostomids, unidentified[e] | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - |
| Ictalurus melas | - | - | - | - | - | * | - | - | - | - | - | - | - | - | - | - |
| Fundulus kansae | - | - | 5 | * | * | - | - | - | - | - | - | - | - | - | 23 | 5 |
| Cottus bairdi | - | 1 | - | - | - | - | - | - | - | - | - | * | - | 1 | - | 1 |

[a]Key to generalized habitat types: a- backwater, b- pool, c- shoreline, d- chute channel, e- riffle, f- run.

[b]Larvae and juveniles less than or equal to 20 mm TL (≤20) were probably spawned within about 5 weeks of the date of collection. Specimens greater than 20 mm TL (>20) include older larvae and young-of-the-year juveniles as well as older juveniles and adults.

[c]* = <0.5%; - = no specimens collected.

[d]The identity of the smaller specimens as catostomid hybrids is tentative. In addition, a few of the smaller specimens identified as pure species may in fact be hybrids.

[e]Specimens were field processed and released before identity could be ascertained.

Department of the Interior 1976). Their section II, which purports to describe the existing environment, states that (pages II-63 and II-64): "In general, major stream fisheries in the western segment of the study region are dominated by such warm-water species as catfish, carp, sunfish, bass, crappie, and pike. The White and Yampa Rivers characteristically change from warm water to cold water fisheries in an eastward direction. For instance, the fish population of the Yampa River changes from 30 percent chubs, 20 percent carp, 15 percent squawfish, ten percent channel catfish, ten percent suckers, ten percent rainbow trout, and five percent brown trout at its confluence with the Green River in Moffat County, to 80 percent rainbow trout, ten percent brown trout, five percent whitefish, and five percent suckers in Routt County south of Steamboat Springs." The source of these interesting figures was not mentioned.

Further studies related to the Yampa Project were conducted by Ecology Consultants, Inc. (1976a, b, c and d) to census fishes near and in the intake structures at Craig and Hayden power plants in November, 1975, and May, 1976. Rainbow trout, brown trout, mountain whitefish, roundtail chub, redside shiner, speckled dace, white sucker, flannelmouth sucker, bluehead sucker and mottled sculpin were collected near Craig Station by electrofishing, gill netting and seining. Longnose suckers (*Catostomus catostomus*) were listed among the fishes collected, but identification was said to be "uncertain due to hybridization." Mottled sculpins were the predominant species, in spite of collection of only one specimen in May, 1976. Mountain whitefish (the predominant game fish caught) and white suckers were second in overall abundance. Fishes collected by electrofishing and gill netting near Hayden Station were rainbow trout, brown trout, mountain whitefish, roundtail chub, redside shiner, speckled dace, fathead minnow, white sucker, flannelmouth sucker, bluehead sucker and mottled sculpin. Longnose suckers were again tentatively identified. Sculpins, caught only by electrofishing, appeared in greatest numbers. White suckers were second in abundance, and whitefish were the most abundant game fish collected. At both locations, few sculpins were collected in the spring and bluehead suckers were collected only in the spring. Entrainment and impingement were discussed in these reports, and efforts were made to collect fish eggs and larvae by conical metered net tows in May, 1976. Only redside shiner postlarvae were collected and only near Craig Station. Redside shiners were considered the fish most susceptible to entrainment and impingement.

Water resources and quality have been emphasized in several recent studies. Burkhard (1966) included the Yampa River in a 1964 survey of Colorado streams. A flow-duration curve for the Yampa at Steamboat Springs (1956 through 1963) was presented. Stream flow was measured, habitat was classified, and 15 bottom samples were collected at one station on the Yampa River. Invertebrates (identified to order or class) from deep and shallow fast-water zones were compared by number and volume. Water chemistry was also analyzed. Fishes were not collected. Yampa River data were also included in Weber's (1966) inconclusive comparison of Colorado stream-survey data. Discharge, sediment and temperature data on the Yampa River were reported in the U.S. Geological survey reports by Iorns, Hembree, Phoenix and Oakland (1964) and Iorns, Hembree and Oakland (1965). The Colorado Water Conservation Board (1969) reviewed the water resources of the Yampa River basin.

Eddy (1975) concluded that point-source discharges in a study area from Steamboat Springs to Hayden, Colorado, had markedly affected diversity of benthic invertebrates. Pennak (1975) described conditions in the vicinity of Steamboat Springs as "badly degraded" and the stream fauna as "depauperate." Stream substrates were reported covered with a thick layer of detritus which provided poor habitat for benthic insects.

Wentz and Steele (1976) compiled gage data for the Yampa and Little Snake Rivers; seasonal temperature, suspended sediment, discharge, conductance vs. cation concentration and water-quality data were also presented. Bauer, Steele and Anderson (1978) presented a detailed water-quality analysis and plotted Eddy's (1975) and Ames' (1977) diversity indices against pollutant concentrations and distance from the mouth of the Yampa River. Steele, Wentz and Warner (1978) reported on a float-trip through Dinosaur National Monument in August 1976. Temperatures, conductance, bottom sediment quality, and some habitat (pool:riffle) assessment were presented.

Endangered species reports mentioned in our review of White River literature are also pertinent to the status of such species in the Yampa River. Papers by Behnke (1973d) and Vanicek and Kramer (1969) should be added to those previously cited.

Table 5 contains a summary of fishes collected from the Yampa River in major papers which have been cited. As was the case with the White River data, benthic invertebrate and water-quality data were considered too complex to summarize in this manner.

## DESCRIPTION OF STUDY AREAS

The Yampa River is a major northwestern Colordo waterway (average annual discharge = 1.2 million acre feet) which arises in the National Forest west of Yampa, Colorado, and flows east, north and then west 175 km before its confluence with the Green River in Dinosaur National Monument. The White River

Table 5. Summary of fishes reported from the Yampa River in Colorado.

| | Baily & Alberti (1952) | Banks (1964) | Holden & Stalnaker (1975a) | Holden & Stalnaker (1975b) | USDA, REA, (1974) | Seethaler, McAda and Wydosky (1976) | Prewitt, Wick & Snyder (1978) | Ecology Consultants (1976) |
|---|---|---|---|---|---|---|---|---|
| Prosopium williamsoni | X | | X | X | X | X | X | X |
| Salmo gairdneri | X | | X | X | X | X | | X |
| S. trutta | X | | X | X | | X | | X |
| S. clarki | X | | X | X | | X | | |
| Cyprinus carpio | X | X | X | X | | X | X | |
| Gila atraria | | | | | | X | | |
| G. robusta | | X(?) | X | X | X | X | X | X |
| G. elegans | | | X | X | | | | |
| G. cypha | | | X | X | | X | | |
| Notropis stramineus | | | | | | X | X | |
| N. lutrensis | | | X | | | X | | |
| Pimephales promelas | | X | X | X | | X | X | X |
| Ptychocheilus lucius | X(Gila?) | X | X | X | | X | | |
| Rhinichthys osculus | X | X | X | X | X | X | X | X |
| Richardsonius balteatus | | X | X | X | X | X | X | X |
| Semotilus atromaculatus | X | X | X | | | X | | |
| Rhinichthys osculus x Richardsonius balteatus? | | | | | | | X | |
| Catostomus commersoni | | | X | X | X | X | X | X |
| Xyrauchen texanus | | | X | X | | X | | |
| C. discobolus | X | X | X | X | X | X | X | X |
| C. latipinnis | X | X | X | X | X | X | X | X |
| C. commersoni x discobolus | | | X | | | X | X | |
| C. commersoni x latipinnis | | | X | | | X | X | |
| C. latipinnis x X. texanus | | | X | | | X | | |
| Ictalurus melas | X | | X | X | | X | X | |
| I. punctatus | X | X | X | X | | X | | |
| Fundulus kansae | | | | | | X | X | |
| Cottus bairdi | X | X | X | | X | X | X | X |
| Lepomis cyanellus | X | X | X | X | | | | |
| L. macrochirus | | | X | X | | | | |
| Mictopterus salmoides | | | X | X | | | | |
| Stizostedion vitreum | | | X | X | | | | |

is a smaller waterway (average annual discharge = 420,000 acre feet) with headwaters on the White River Plateau. It flows west for approximately 140 km and joins the Green River near Duchesne, Utah. Both rivers are major tributaries of the Colorado River and are presently unaffected by major impoundments.

Fish sampling stations

Six major stations for fish collection were established on the Yampa and White Rivers in the summer of 1975. Additional stations were subsequently established for reasons mentioned below.

Four original Yampa River stations (Y-1 through Y-4) were located between Hayden, Colorado, and Lily Park Pool west of Cross Mountain Canyon (Figure 1, Table 6). More detailed station descriptions were presented by Prewitt (1977). Two additions to the original Yampa River stations were Stations Y-4a and Y-2j (Figure 1, Table 6). Station Y-4a was established late in 1974 and was sampled occasionally thereafter; it was located at the base of Cross Mountain Canyon and contained unique deep-water canyon habitat. In 1977, access to Station Y-2 was fenced; an alternative sampling site was established near Juniper Hot Springs, Colorado, and designated Station Y-2J (Figure 1, Table 6). Because the environment at and collections from Station Y-2J were significantly different from those of Station Y-2, Y-2J was considered a new station rather than a substitute for Y-2.

A canoe trip was made on August 16-18, 1977, and fishes were collected by seine and dipnet at six additional stations (Y-2a through Y-2f) on the Yampa River between Craig and Juniper Springs Canyon (Figure 2).

Two permanent fish sampling stations on the White River (W-A and W-B) were established in 1975 (Figure 1, Table 6). More detailed descriptions

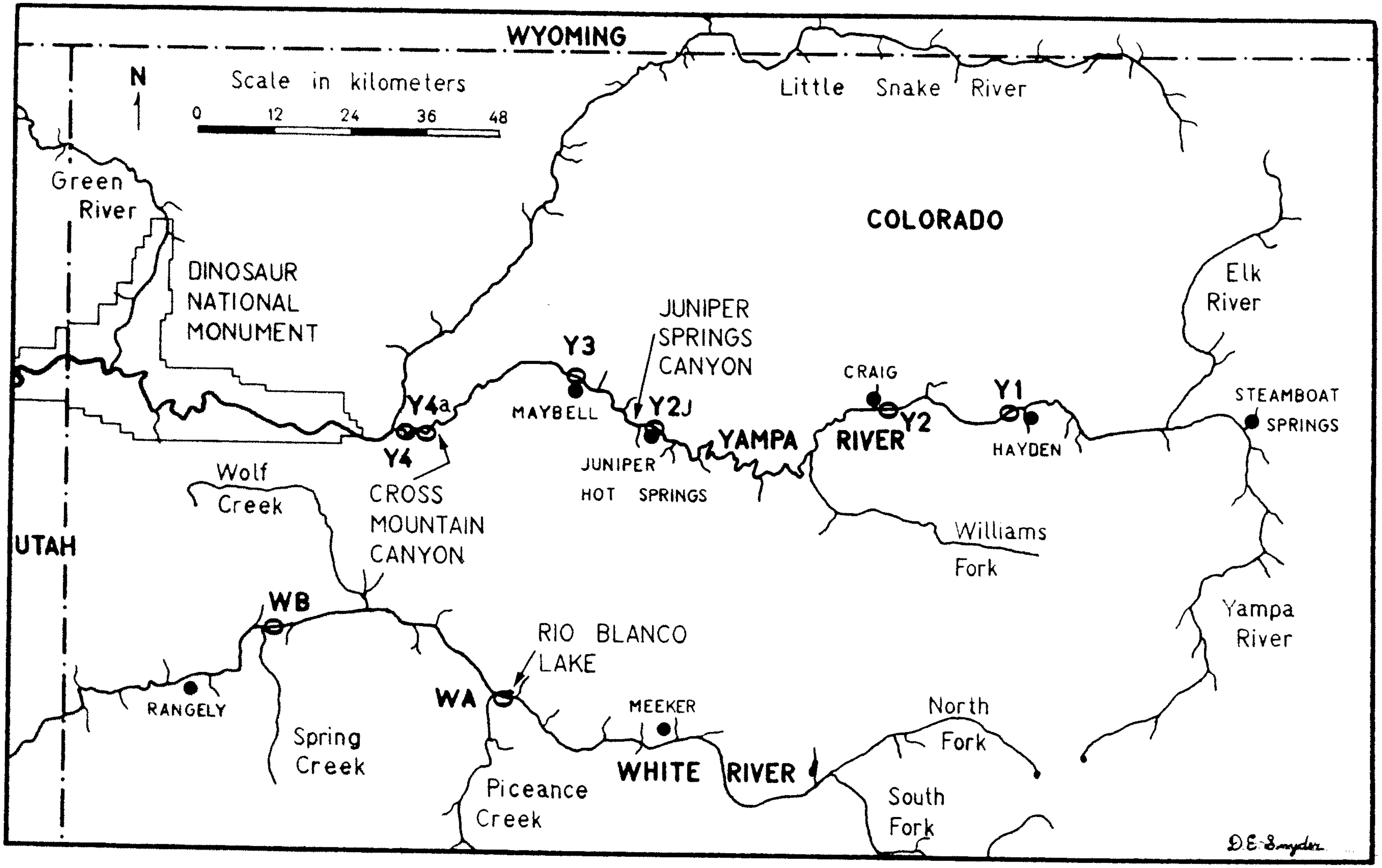



Figure 1. Location of Yampa and White River fish-sampling stations.

Table 6. Location of fish sampling stations on the Yampa (Y) and White (W) Rivers in Colorado, 1975-1978, with descriptive notes.

| Station | Location | Elevation, ± 10m | Predominate Substrates | Major Features | Shoreline and Adjacent Areas |
|---|---|---|---|---|---|
| Y-1 | Above and below[1] U.S. Highway 40 bridge about 3 km west of Hayden. | 1920m | Cobble. | Stream divided by large island with several shallow backwater areas; lower portion of site highly modified by bulldozer activity creating a large backwater in 1977. Lowest portion of site divided by still another island. | Both shores with dense stands of cottonwoods with relatively open grassy or willow-lined areas between. |
| Y-2 | Near the Craig golf course parking lot about 2(+) km southeast of Craig. | 1890m | Cobble and rubble. | Two large pools separated by a channelized segment about 1 km long; cross-sectional contours relatively uniform with the river occupying much of its channel throughout the observed range of flows. | Shores mostly with grasses and brush but with a few dense stands of cottonwood, neighboring areas devoted to wheat farming. |
| Y-3 | Above[1] and below county road bridge about 2 km north of Maybell. | 1790m | Cobble and rubble (unknown in pools) | Broad riffle above bridge and pool and sand bars below bridge. | Area east of the bridge along the north shore consists largely of steep eroding slopes with semi-arid sage-desert vegetation and a few willow and cottonwood trees near the river; elsewhere, the terrain is flat and hay production predominates. |
| Y-4 | Lily Park Pool about 3(+) km west of the base of Cross Mountain Canyon to below county road bridge about 4(-) km west of the base of Cross Mountain Canyon.[2] | 1720m | Cobble and rubble (unknown in pools); large sand and silt deposits along the inside curves of the Lily Park Pool area. | High frequency of alternating riffles and pools with several meanders. Numerous eddies and backcurrents within major pool area (Lily Park). | Surrounding basin is semi-arid, notably eroded, and vegetated largely of steep eroding slopes with semi-arid sage-desert vegetation and a few willow and cottonwood trees near the river; elsewhere, the terrain is flat and hay production predominates. |
| Y-4a | Base of (lower entrance to) Cross Mountain Canyon. | 1720m | Rubble, boulders, and sand. | Large deep pool mostly within high, steep canyon walls with a boulder and rubble bar below the canyon mouth. | Within the canyon, the stream is bounded by steep cliffs with little vegetation; outside the canyon, terrain and vegetation is similar to Y4. |
| Y-2J | Around and near temporary alluvial island (connected to south shore during lower flows) across from Juniper Hot Springs. | 1830m | Cobble and gravel; sand and silt in backwaters. | Large alluvial island divides the river during high flow and provides a large backwater during low flow. | Large open basin; south shore and alluvial island with willows and grasses; north shore sparsely vegetated with grasses and sagebrush. |
| W-A | Above and below northwestern boundary of the Rio Blanco Lake State Recreation Area, just east of the Piceance Creek Road Bridge. | 1770m | Cobble; sand and silt in backwaters. | Main channel turbulent with many riffle areas; large chute-channel/backwater along north store; smaller channel/backwater areas created by bars of cobble, sand and silt. | Vegetation around the site consisted largely of dense stands of willow and grasses; the general surrounding area also supports stands of cottonwoods and hay fields. |
| W-B | Above and below[1] north of Hammond Draw and an old farm bride below it, about 16 km northeast of Rangely. | 1650m | Cobble. | Numerous riffle areas with slow-flowing pools and small backwaters restricted to nearshore areas. | Bankside vegetation is dominated by grass, willow, cottonwood and "salt" cedar. Hay meadows dominate the neighboring agricultural lands. |

[1]Portion emphasized in seine and dip net collections.

[2]Latter portion not sampled after 1976.

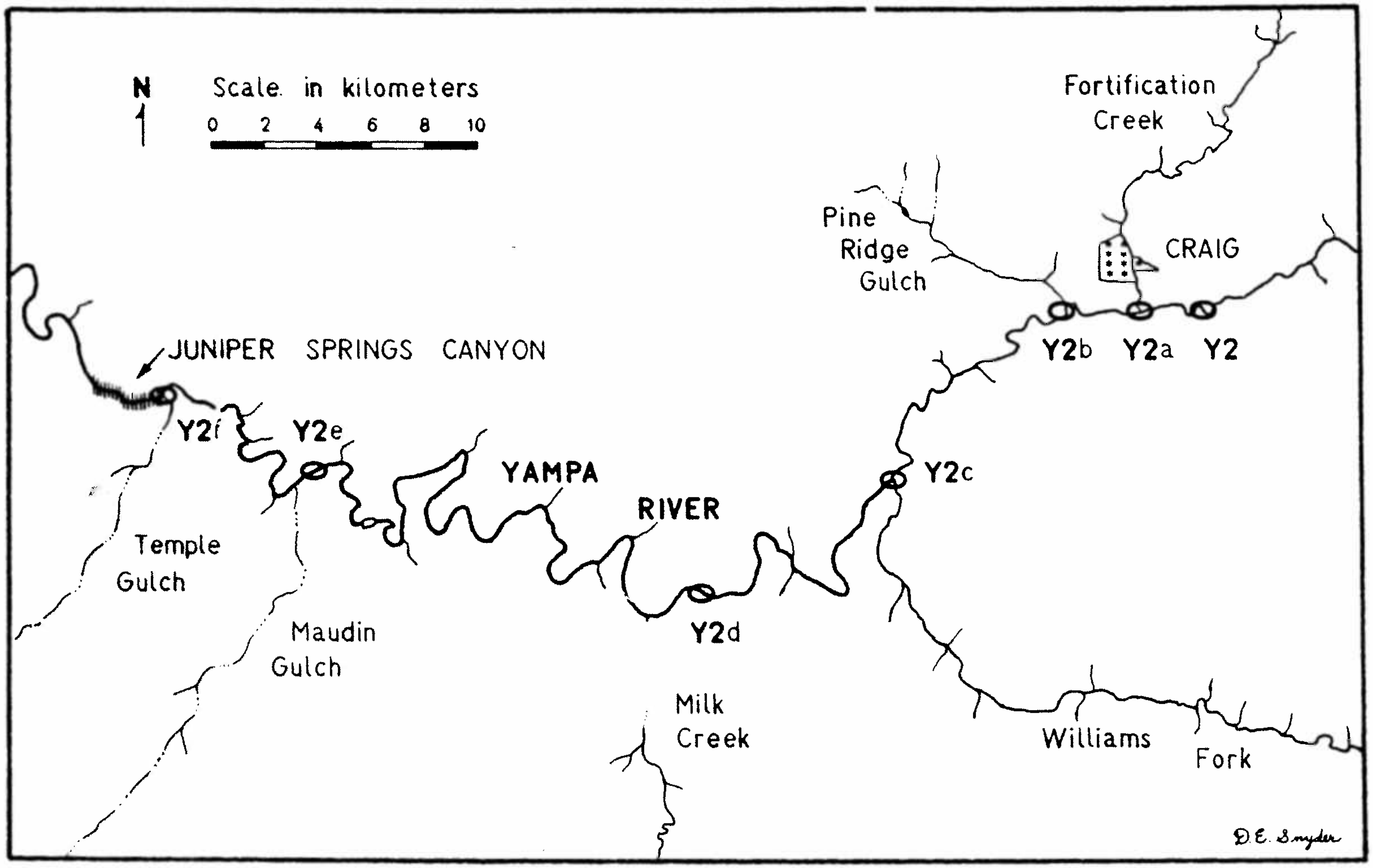



Figure 2. Sites sampled during canoe trip from Craig to Juniper Springs Canyon during August 16-18 1976: Y2 - along east end of Craig golf course; Y2a - at mouth of Fortification Creek, about 2.5 km west of Y2; Y2b - at mouth of Pine Ridge Gulch and islands about 0.5 km west; Y2c - at mouth of Williams Fork; Y2d - at large island about 2.5 km northeast of mouth of Milk Creek; Y2e - at and just below Government Bridge, about 1.5 km northeast of mouth of Maudin Gulch; Y2f - entrance to Juniper Springs Canyon in vicinity of the mouth of Temple Gulch.

of these stations were presented by Prewitt (1977). Fishes collected approximately 10 km downstream from Station W-A in August, 1976, were combined with W-A collections for analysis.

Special field work was conducted in 1978 to 1) obtain gametes from flannelmouth suckers and bluehead suckers for artificial fertilization to allow us to raise a larval series for identification purposes, and 2) determine the current distribution of endangered fishes within our sampling area. Fish sampling was conducted April 21-22 at Stations Y-2J, Y-3, Y-4, and W-A. On May 20-21, sampling was conducted at Round Bottom, 1.0 km downstream from Craig, and at regular sites Y-2J and Y-3. Electrofishing at Round Bottom was conducted in cooperation with Mr. Dale Thompson, a biologist with Colorado-Wyoming Coal Company. This special site was sampled because of its unique and diverse habitat. Backwaters in this river section have been selected for modification and preservation as potential squawfish nursery areas by Colo-Wyo Coal Co. Stations W-A, W-B, Y-2J, and Y-4 were sampled on May 31-June 1. On June 25, Station W-A was sampled again. Another special field trip planned and sponsored by the Colorado Division of Wildlife was conducted October 10-12 after termination of our BLM contract; Cross Mountain and Juniper Springs Canyons were sampled specifically for endangered fish distribution.

Macroinvertebrate sampling sites

Sampling sites for aquatic macroinvertebrates were chosen in a non-random manner, approximately equally-spaced along a longitudinal gradient, below major tributaries and/or towns. No effort was made to locate macroinvertebrate collection sites at fish sampling stations.

The Yampa River was sampled at six sites (Y1-Y6) from Steamboat Springs to Cross Mountain, a distance of about 177 river km (Figure 3, Table 7).

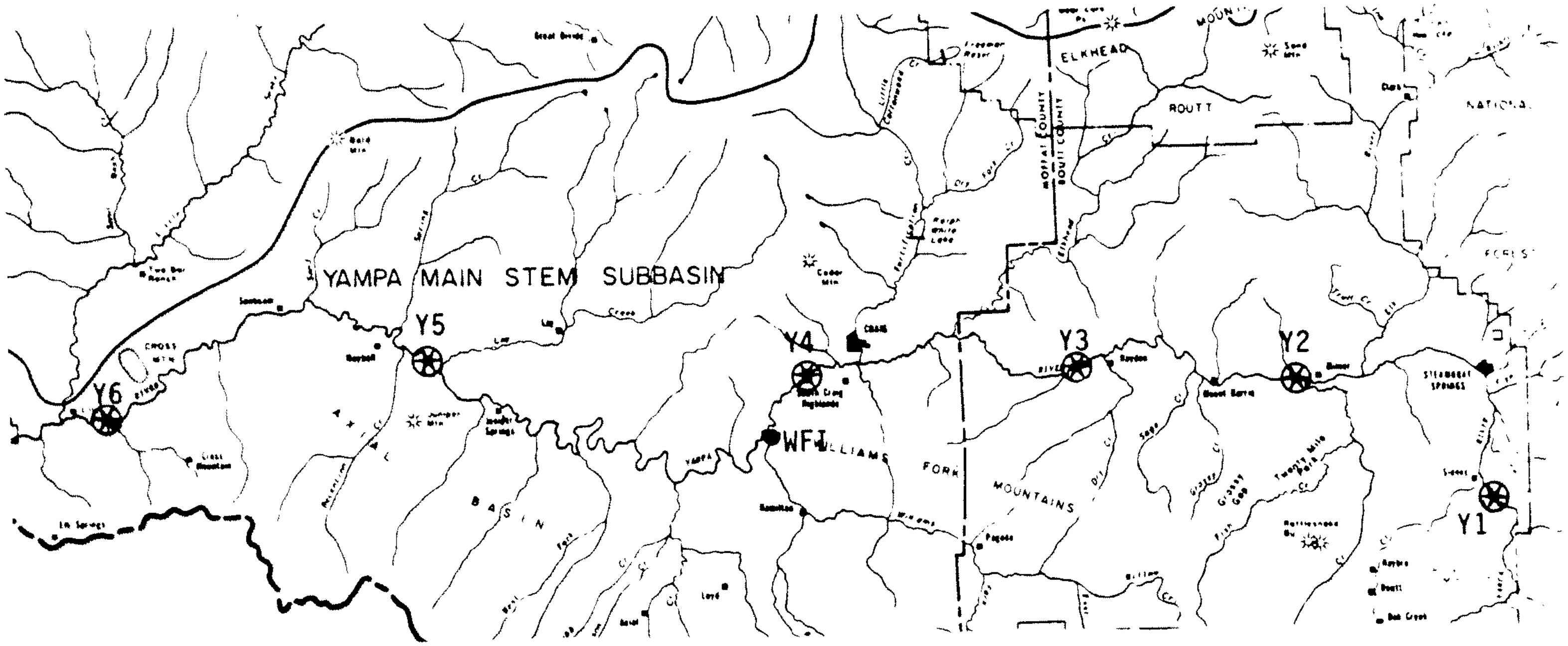



Figure 3. Macroinvertebrate sampling sites on the Yampa River, Colorado.

Table 7. Macroinvertebrate sampling sites on the Yampa River and Williams Fork River, Colorado.

| Site | Location | Elevation | Below Tributary | Substrate Type | Site Description | Dates Sampled | |
|---|---|---|---|---|---|---|---|
| Y1 | Upstream and southwest of Steamboat Springs--6.4 km south on Hwy 131 from Hwy 40--site is upstream from a bridge which crosses Hwy 40. | 2112.26m | Oak Creek | Boulder, rubble, gravel, some silt and sand in the pools, organic matter. | Ranches and grazing land--banks are rocky, grassy, and eroding dirt--willows "brush" and "open." | 7-75<br>8-75<br>9-75<br>10-75 | |
| Y2 | .64 km west of Milner south off of Hwy 40 dirt road where a bridge corsses the river--the site is upstream from a bridge. | 1902.56m | Trout Creek<br>Elk River | Rubble, gravel, silt in pools. | Hayfields, bushes and willows--banks are rubble and silt, "brush" and "open." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 4-76<br>5-76 |
| Y3 | 2.2 km west of Hayden down a dirt road which turns south off of Hwy 40 just after a bridge over the Yampa. | 1987.3m | Wolf Creek<br>Sage Creek | Rubble, gravel, sand, silt at edges and in pools. | Cottonwoods and willows fairly thick--banks are straight cut mud and eroding, "forest" and "brush." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76<br>7-76<br>9-76<br>10-76 |
| Y4 | 4.8 km west and south of Craig--down a dirt road east off the Hwy to Meeker--the site is .8 km down this road. | 1881.8m | Fortification Creek | Rubble, gravel, much detritus & organic matter, much silt. | Sage and grasses--some willows and cottonwoods upstream--banks are eroding mud and silt, "open" and "brush." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>7-76<br>8-76<br>9-76<br>10-76 |
| Y5 | 4.8 km east of Maybell downstream from the Hwy 40 bridge--turn off right on dirt road before bridge and drive to river. | 1804.4m | Williams Fork<br>Lay Creek | Rubble, gravel, with much sand and silt mixed in. | Sagebrush and juniper--sloping dirt banks--semi-arid, flat country, "open." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76<br>7-76<br>8-76<br>9-76 |
| Y6 | 24.14 km west of Maybell, 7.24 km on the side road to Cross Mountain; the site is about 1 km from Cross Mountain Gorge next to a clump of willows. | 1798.32m | Spring Creek | Rubble, gravel, sand and silt mixed in homogeneously. | Semi-arid with sage, junipers, and salt brush, "open." | 11-75 | 3-76<br>4-76<br>5-76<br>7-76<br>8-76<br>9-76<br>10-76 |
| WF1 | .8 km downstream from a coal mine and 1.1 km above where the river meets the Yampa--turn off Hwy to Meeker about 11.3 km from Craig onto Coal Road--site is downstream from the bridge on the Coal road. | ~1900m | Tributary of the Yampa | Heavily silted rubble and gravel. | Grazing lands with willows and cottonwoods,"forest" and "brush." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76 |

There was a 304.8-m change in elevation, an average gradient of about 2%, within the sampling area. Sampling at Site Y1 was discontinued at the end of October 1975 because the site was being channelized. Site Y5 was added in November 1975 as an additional downstream site.

One site (WF1) was established on the Williams Fork River, a major tributary of the Yampa River. Site WF1 was situated immediately below a coal mine to determine community types in a heavily-silted area. Sampling was discontinued at WF1 in July 1976 because of extensive bulldozing in the area.

An 88.5-km reach of the White River from Meeker to Rangely was sampled at four sites, W1A and W1-W3 (Figure 4, Table 8). At all sites below Meeker, the substrate contained considerable silt, and the water was never completely clear at any time of the year. All sites on the Yampa River experienced periods of clear water during low flow.

Generally, riparian vegetation at the upper stations on the White and Yampa Rivers consisted of willows and cottonwoods; the lower sites were bordered by sagebrush, saltbrush, rabbitbrush and some willows. There was a greater percentage of rubble and pebble substrates at higher elevations and a greater percentage of silt and sand at sites at lower elevations.

Habitat assessment

Detailed dimensional measurements were made with surveying and stream-flow-determination equipment 1) directly above and below the Yampa River bridge on county road 25 north of Maybell, Colorado (corresponding to fish-sampling Station Y-3); 2) near Lily, Colorado (corresponding to Station Y-4); 3) above the Piceance Creek confluence with the White River (corresponding to Station W-A); and 4) near the Rio Blanco County road 65 bridge (about 10 km below Station W-A).

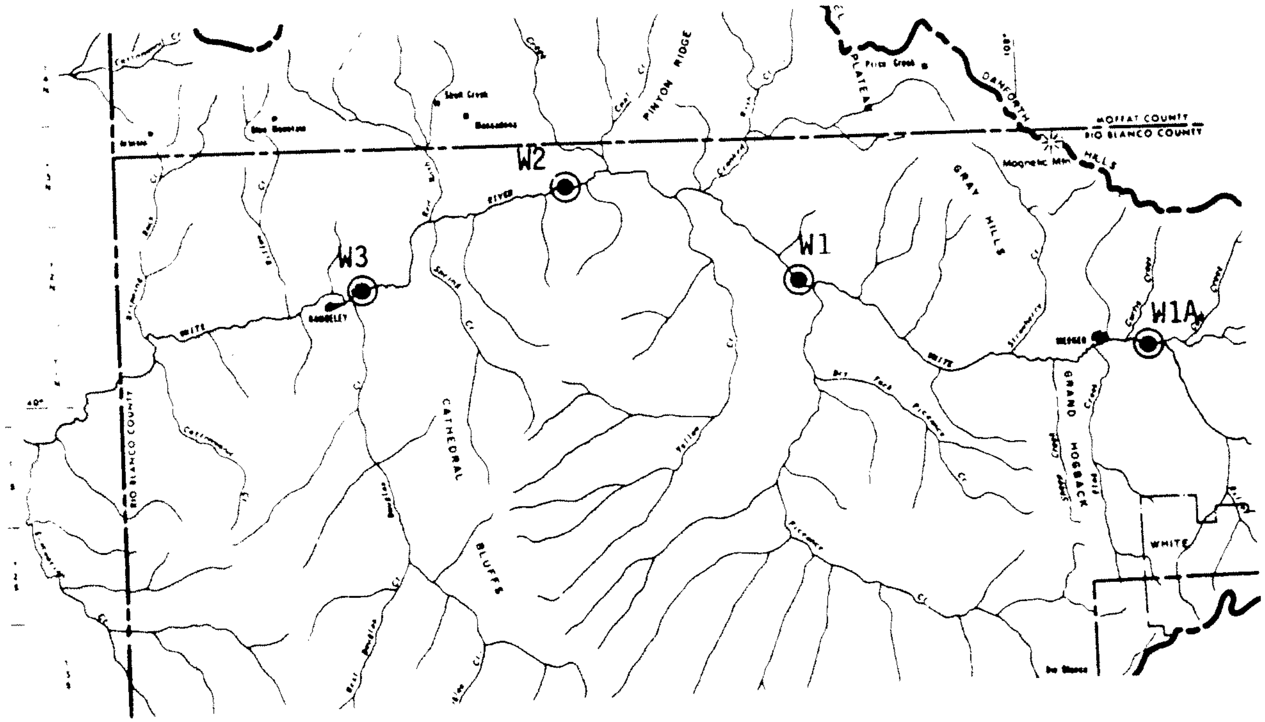



Figure 4. Macroinvertebrate sampling sites on the White River, Colorado.

Table 8. Macroinvertebrate sampling sites on the White River, Colorado.

| Site | Location | Elevation | Below Tributary | Substrate Type | Site Description | Dates Sampled | |
|---|---|---|---|---|---|---|---|
| W1A | 4 km west of Meeker off of Hwy 32 at the USGS gaging station--the site is upstream from the bridge. | 1981.2m | Coal Creek | Boulder, rubble, gravel, very little silt in pools. | Willows, cottonwoods, other trees--grassy banks--with rock,"forest." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76 |
| W1 | 1.2 km below where Piceance Creek flows into River--the site is downstream from the Hwy 64 bridge. | 1728.2m | Piceance Creek | Rubble, gravel, much silt in pools and edges. | Grazing lands and hayfields bordered by high bluffs--semi-arid, sage region--grassy banks, "open." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76<br>7-76<br>8-76<br>9-76 |
| W2 | 27.35 km downstream from site W1--11.26 km below confluence with Yellow Creek--short dirt road turns towards river. | 1645.9m | Yellow Creek | Rubble, gravel, much silt in pools and edges--silt in riffles. | Grazing lands and hayfields bordered by high bluffs--semi-arid, sage region, eroding mud banks, "open." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76<br>7-76<br>8-76<br>9-76 |
| W3 | .4 km east of Rangely about .4 km down a dirt road north off of Hwy 64. | 1607.5m | Spring Creek Douglas Creek | Rubble, gravel, sand, all mixed with silt, homogeneously. | Arid--sage--saltbrush community--some willows. Eroding silt banks, "open." | 7-75<br>8-75<br>9-75<br>10-75<br>11-75 | 3-76<br>4-76<br>5-76<br>7-76<br>8-76<br>9-76 |

# FISHES

*Methods*

## Collections

Routine fish collections were made on July 10-12 and 18-20, August 6-8 and 26-28, and September 19, 1975; March 20, May 19-21, June 1-3 and 22-24, July 15-17, August 4-6 and 16-19, and October 9-10, 1976; and April 22-23, May 25-27, June 27-28, July 27-31 and August 30-31, 1977. A canoe sampling trip between Station Y-2 and Juniper Springs Canyon above Y-3 was conducted on August 16-18, 1976. Fish were also taken about 10 km below W-A during a cooperative electrofishing trip with Colorado Division of Wildlife Biologists on August 26, 1976 (data were combined with W-A data). Additional trips were made during 1978 to collect endangered fishes and fish gametes.

Procedures and techniques for fish collection were varied in accordance with water conditions to most efficiently sample fish communities. As experience was gained, procedures became more standardized. Electrofishing gear was used wherever suitable throughout the study, usually over deeper waters in pools and along banks, and occasionally in backwater areas. Electrofishing equipment was mounted aboard a 4.8-m flat-bottomed boat fitted with two 3.3-m fiberglass booms. The booms held 1.5-m X 9.5-mm steel-cable electrodes, and 3.1-m X 9.5-mm cable electrodes were mounted in the middle of the boat. Power was supplied by a 3500-watt 60-cycle generator and modulated through a Coffelt Model VVP-3E variable voltage pulsator (VVP) control box. Type and amount of current, frequency of pulse, and area of electrodes were varied depending on water conditions. High water conductivity dictated that minimal electrode surface area (obtainable only by boom-to-boom operation) be used during most of the summer months. Conductivity over 1400 $\mu$mho/cm$^3$ actuated a protective circuit in the VVP box to stop current. Hand-held electrodes with long cords were occasionally used to sample areas inaccessible by boat during low flow. Small fish were occasionally collected with finer-mesh dipnets during electrofishing; these specimens were usually included and processed with seine collections.

A commercial gill net (9.14 m x 3.1 m x 50.8-mm mesh) and an experimental gill net (45.7 m x 1.8 m with 3.2-mm to 38.1-mm mesh) were used in 1975 and March 1976. Nets were set at dusk and picked the following morning before daybreak. Gill net data are reported herein as part of the electrofishing results. Various seines were used depending on their availability and specific conditions at each station in 1976 and 1977 (and minimally in 1975 to determine species present). The most effective seines for small fish had a mesh of about 3.2 mm. Fine-mesh (0.5-1.0 mm) dipnets were used in 1976 and 1977 to collect larvae and supplement seine collections in shallow shoal, backwater and shorelines areas. Seine and dipnet collections were combined for analysis. A conical 0.5-m plankton net (0.5-mm mesh) was used experimentally in 1976. It was held in a stationary mid-stream position for 5 min at each site sampled. Commercial cylindrical minnow traps were used briefly in 1976; captures were processed as part of the seine collections.

## Sample Processing

Most larger fish were field-processed and released; many smaller fish, especially larvae and early juveniles, were preserved for processing in the laboratory. The latter specimens were initially fixed in 5-10% formalin and later stored in 3% buffered formalin. Large specimens were stored in 70% ethanol. All fish were identified, enumerated, and measured to the nearest millimeter total length (TL). Large, field-processed collections of the same species were sometimes subsampled for measurements. Larger fishes were also weighed to the nearest gram, and scales and/or pectoral rays were usually removed for age determination. Scales were removed from selected fish midway between the lateral line and the anterior margin of the dorsal fin. Additional measurements were made of selected specimens for taxonomic work. Stomachs of larger fish killed during collections were removed, preserved and returned to the laboratory for analysis. Since carp and suckers were rarely killed by electrofishing, a subsample of these fishes representing the length range within the sample was sacrificed at each station. Only a few game fish were sacrificed during each sampling effort to avoid reductions in their populations. Entire alimentary tracts of cyprinids and catostomids were preserved in 10% formalin, but only the stomach and esophagus of salmonids were retained. Notes were often made of sex, reproductive state and unusual characters. Methods of gamete collection and artificial fertilization were similar to those described by Dobie et al. (1956).

Disposition of preserved fishes

Specimens 50 mm TL or less were sorted according to size and source for inclusion in developmental, voucher, and reference series. The series were deposited with the Laboratory for the Identification and Study of North America's Freshwater Larval Fishes at Colorado State University's Department of Fishery and Wildlife Biology (CSU-DFWB). Voucher series will also be deposited with the Fish and Wildlife Service Museum in Fort Collins, Colorado. Excess specimens and specimens over 50 mm TL were catalogued and retained.

## Fish identification

Generally, identification of juvenile and adult fishes posed little difficulty, but identification of larval forms required considerable comparative study. Identification errors have been discovered, or refinements made, since preparation of our various progress reports. References used in verifying some identifications were Baxter and Simon (1970), Beckman (1952), Bragensky (1960), Crawford (1923), Crawford (1925), Douglas (1952), Eddy (1957), Everhart and Seaman (1971), Fish (1932), Fuiman (1978), Hogue et al. (1976), Holden and Stalnaker (1970), Hubbs and Hubbs (1947), Jordan and Evermann (1896), Koster (1957), Lindsey and Northcote (1963), Lippson and Moran (1974), Long and Ballard (1975), Mansueti and Hardy (1967), May and Gasaway (1967), Minckley (1973), Moore (1968), Pflieger (1975), Saksena (1962), Scott and Crossman (1973), Seethaler (1978), Sigler and Miller (1963), Smallwood and Smallwood (1931), Smith (1966), Smith (1973), Snyder et al. (1977), Suttkus and Clemmer (1977), Taber (1969), Weisel and Newman (1951), and Winn and Miller (1954). Preserved specimens in the CSU-DFWB teaching collection and in the larval fish reference collection maintained by Darrel E. Snyder (including a partial series of Colorado squawfish provided by Karl Seethaler) were also utilized in verifying identifications. Use of common and scientific names followed the American Fisheries Society list prepared by Bailey et al. (1970).

## Age and growth

Cleaned scales were mounted between a pair of glass slides and viewed on an Eberbach scale projector by two or three observers on two separate occasions to determine age. Scale radius measurements were made from the focus to the middle of the anterior scale margin, and focus-annulus measurements were made along the same radius to the outer edge of each annulus (Tesch 1971). Past growth history was determined by standard back-calculation procedures. Back-calculated lengths were averaged for each year class. Because squawfish scales had compressed circuli in the anterior field and annuli were difficult to distinguish there, the lateral and posterior fields were also used for age determinations. In several instances, apparent annuli in the lateral and posterior fields could not be verified in the anterior field, possibly because of resorption. Since exact age could not be determined by comparing annuli on the anterior and posterior fields, ranges of squawfish ages between the conservative anterior count and the higher posterior count were recorded.

Annuli were difficult to distinguish on bluehead and flannelmouth sucker scales but relatively easy to discern on thin cross-sections of their first pectoral rays. The pectoral rays were dipped in epoxy to prevent splintering (Witchers 1975) and sectioned with a small circular saw blade fitted to a Dremel Moto-tool. The sections were then placed on a glass slide and studied under a microscope with transmitted light and polarizing filters. Age was determined by counting the opaque rings, as with sectioned otoliths (Williams and Bedford 1973). To determine the reliability of pectoral ray ageing, scales and ray sections of white sucker hybrids were studied first. Scales of white suckers and their hybrids have easily-distinguishable annuli. Numbers of annuli on rays and corresponding scales were then compared and reliable relationships established.

Ageing and back-calculationg data were compared with length-frequency distributions to verify that the annuli (or apparent annuli) observed on scales or sections were neither missed nor misinterpreted.

## Spawning times

All fishes collected by seine and dipnet were measured to the nearest millimeter and recorded by date of capture on length-frequency charts for each river and year. Selected literature was reviewed for reproductive information including size at hatching. Hatching dates were estimated from the young-of-the-year portions of length-frequency tables by assuming an average growth rate of about 0.5 mm/day and calculating the approximate size at hatching. The approximate number of days required for incubation at the encountered temperatures were then taken into account to estimate spawning dates. This method was easily incorporated into our collection procedure and allowed determination of the entire spawning period. It was less time consuming than direct observation of spawning and caused less mortality than egg-maturation methods (as used by Andreasen and Barnes 1975).

## Food habits

Mountain whitefish, rainbow trout and roundtail chubs were the only species for which food habits could be analyzed by standard numeric, volumetric and frequency-of-occurrence methods. Components of the rations of suckers and carp comprised by detritus, periphyton and invertebrates were identified by a phycologist and Mr. Prewitt, respectively. Algal components were identified to the finest taxonomic level possible considering the physical state of the specimens. In most cases, aquatic invertebrates could be identified to family.

Volumes of certain invertebrates were reconstructed by measuring the total volume of all organisms of one taxon from a stomach sample by displacement. Volumes of individual organisms could then be calculated by dividing the sample volume by the number of organisms. Volumes of small numbers of organisms were then determined by multiplication. If too few representatives of a taxon were present, their physical dimensions were compared to those of organisms of known individual volume and the unknown volumes estimated. Electivity (E) values, as suggested by Ivlev (1961), were determined when possible.

Data analysis

Due to differences in sample and specimen sizes collected and specific habitats sampled, electrofishing and seine-dipnet data were analyzed separately. The electrofishing sample was analyzed with a FORTRAN IV computer program (ANALYS) developed by Leonard Willoughby and Charles G. Prewitt at CSU. Input consisted of date, year and station of sampling effort and species, total length, weight, standard length, head length and caudal peduncle depth of each fish caught. Cards were input in random order and sorted by sampling station, date, species and total length. Output options included 1) summary statistics (mean condition factor and mean, variance, standard deviation and range of total length of each species for each sampling effort); 2) cumulative statistics for each station based on the total sample from the 1975-1977 collecting period; 3) a list of all fish collected during the 1975-1977 period, ordered by length with all morphometric measurements and computed K (condition coefficient) for each individual; and 4) a length-frequency histogram for species of fish having more than 20 individuals at a specified sampling station during any single year of the study. All other data were assembled manually.

Fish identification

Hybrid specimens posed the only serious juvenile (recently-transformed specimens excepted) and adult identification problems. Three catostomid hybrids and one suspected cyprinid hybrid were encountered during the study. The catostomid hybrid crosses and the bases for their identification were documented by Prewitt (1977). Preliminary study of the suspected cyprinid hybrid indicated a cross between the redside shiner and the speckled dace. Dr. Robert R. Miller (University of Michigan Museum of Zoology) offered tentative verification of that determination for one specimen.

Only the cypriniform fishes posed problems in larval and early juvenile (recently transformed) identification. By the end of the study the identify of all cyprinids had been determined with a high degree of confidence except for a few early juveniles suspected to be redside shiner x speckled dace hybrids (discussed earlier) and specimens identified as roundtail chubs. There is great potential for confusing the larvae and early juveniles of roundtail chubs with those of the humpback chub, bonytail chub, or Colorado squawfish. However, no adult (or late juvenile) humpback or bonytail chubs were collected in either the White or Yampa River. The collection of adult squawfish in both rivers certainly enhances the possibility of collecting squawfish larvae. But, based solely on one partial series of squawfish reared in captivity from only one or two broods (and, therfore, with potentially limited morphological variability), we have tentatively discounted presence of that species in our larval and early juvenile samples. Accordingly, we feel justified in naming all as as roundtail chubs. The specimens will be reexamined as detailed developmental studies of the roundtail chub and Colorado squawfish at Colorado State University proceed.

The catostomids posed the most difficult identification problems, especially among the protolarvae and mesolarvae (Snyder 1976a and b). Flannelmouth and bluehead suckers were easily distinguished from one another, but white sucker larvae were found to be intermediate in appearance. Character states occasionally overlapped the extreme of one or the other native species during certain developmental stages. Therefore, a few specimens identified as one of the native species in the Yampa River (no white suckers were found in the White River) may be white suckers or vice versa. The situation is further complicated in the Yampa River by the extensive hybridization between the native suckers and the introduced white sucker, and to a much lesser extent between the two native species. Specimens were categorized as to the species they most nearly resembled and, accordingly, it is likely that some Yampa River specimens identified as a pure species may be hybrids. Specimens which are definitely intermediate in characters between two of the three species have been categorized as the hybrid of those two species, but such identifications must be considered tentative. A few specimens collected in 1976 were so confusing that they were categorized as "unidentified catostomids." Further complications exist in that the larvae of the mountain sucker (undescribed) and of the humpback sucker (very poorly described) are expected to be very similar to those of the bluehead and flannelmouth suckers, respectively. Flannelmouth and humpback suckers have been reported to hybridize in certain portions of their common range. However, adults of neither humpback nor mountain suckers were collected during this study in either river; therefore, the probability of our having collected larvae of either is quite remote. One yearling mountain sucker was taken in the White River, slightly raising the possibility that mountain sucker larvae might have been there.

Distribution

Combining fish collected by all methods during the 1975 through 1977 study period, 18 species and four hybrids representing six families were collected from the Yampa River (Table 9), and 14 species and one hybrid representing five families were collected from the White River (Table 10). Of the fishes collected in the Yampa River, rainbow trout, sand shiners, redside shiners, white suckers and their hybrids, creek chubs, plains killifish and cyprinid hybrids did not occur in the White River collections. Of the White River species, red shiners and mountain suckers were not collected from the Yampa River.

Electrofishing collections

Ten species and three hybrids were collected by electrofishing from the Yampa River (Table 11). The species composition of the catch changed gradually in a downstream direction, with three notable trends. 1) Flannelmouth suckers were the most abundant fish in the electrofishing samples from all stations, and their contribution to the electrofishing catch increased downstream through Station Y-4a. The relatively-lower representation of this species at Station Y-4 in 1977 was due to the release of several fish when the holding tank became too full to accept more captures. 2) Bluehead suckers also

Table 9. Cumulative list of Yampa River fishes captured by seine, dipnet, traps, gillnets and boat electrofishing, July 1975 through October 1977.

| | 1975 | 1976 | 1977 |
|---|---|---|---|
| *Prosopium williamsoni* | X | X | |
| *Salmo gairdneri** | X | X | X |
| *S. trutta* | X | | |
| *Cyprinus carpio* | X | X | X |
| *Gila robusta* | X | X | X |
| *Notropis stramineus** | | X | X |
| *Pimephales promelas* | X | X | X |
| *Ptychocheilus lucius* | X | | X |
| *Rhinichthys osculus* | X | X | X |
| *Richardsonius balteatus** | X | X | X |
| *Semotilus atromaculatus** | | X | |
| *R. osculus* x *R. balteatus*?* | | X | X |
| *Catostomus commersoni** | X | X | X |
| *C. discobolus* | X | X | X |
| *C. latipinnis* | X | X | X |
| *C. commersoni* x *discobolus* hybrid* | X | X | X |
| *C. commersoni* x *latipinnis* hybrid* | X | X | X |
| *C. discobolus* x *latipinnis* hybrid | | X | X |
| *Ictalurus melas* | | | X |
| *I. punctatus* | X | X | X |
| *Fundulus kansae** | | X | |
| *Cottus bairdi* | X | X | X |

*Not found in White River

Table 10. Cumulative list of White River fishes captured by seine, dipnet, traps, gillnets and boat electrofishing, July 1975 through October 1977.

| | 1975 | 1976 | 1977 |
|---|---|---|---|
| *Prosopium williamsoni* | | X | X |
| *Cyprinus carpio* | X | X | X |
| *Gila robusta* | X | X | X |
| *Notropis lutrensis** | | X | X |
| *Pimephales promelas* | | X | X |
| *Ptychocheilus lucius* | | | X |
| *Rhinichthys osculus* | X | X | X |
| *Catostomus discobolus* | X | X | X |
| *C. latipinnis* | X | X | X |
| *C. platyrhynchus** | | X | |
| *C. discobolus* x *latipinnis* | | X | |
| *Ictalurus melas* | X | X | |
| *I. punctatus* | X | | X |

*Not found in Yampa River.

Table 11. Summary of fishes collected by electrofishing from the Yampa River, July 1975 through October 1977, with percentage composition by station and percentage distribution by species.

| Station | Numbers Collected | | | | | | | % Composition | | | | | | % Distribution | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2 | Y-2J | Y-3 | Y-4a | Y-4 | All | Y-1 | Y-2 | Y-2J | Y-3 | Y-4a | Y-4 | Y-1 | Y-2J | Y-2 | Y-3 | Y-4a | Y-4 |
| *Prosopium williamsoni* | 72 | 28 | -- | 1 | -- | -- | 101 | 22.5 | 10.6 | -- | .4 | -- | -- | 71.3 | 27.7 | -- | 1.0 | -- | -- |
| *Salmo gairdneri* | 8 | 10 | -- | 1 | -- | -- | 19 | 2.5 | 3.8 | -- | .4 | -- | -- | 42.1 | 52.6 | -- | 5.3 | -- | -- |
| *S. trutta* | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | .3 | -- | -- | -- | -- | -- | 100 |
| *Cyprinus carpio* | 40 | 2 | 11 | 11 | 2 | 40 | 106 | 12.5 | .8 | 15.5 | 4.3 | 5.7 | 10.6 | 37.7 | 1.9 | 10.4 | 10.4 | 1.9 | 37.7 |
| *Gila robusta* | -- | 8 | 2 | 13 | 5 | 24 | 52 | -- | 3.0 | 2.8 | 5.1 | 14.3 | 6.3 | -- | 15.4 | 3.8 | 25.0 | 9.6 | 46.2 |
| *Ptychocheilus lucius* | -- | -- | 1 | 2 | 3 | -- | 6 | -- | -- | 1.4 | .4 | 8.6 | -- | -- | -- | 20 | 20 | 60 | -- |
| *Catostomus commersoni* | 103 | 104 | 8 | 20 | 1 | 2 | 238 | 32.2 | 39.4 | 11.3 | 7.8 | 2.9 | .5 | 43.3 | 43.7 | 3.4 | 8.4 | .4 | .8 |
| *C. discobolus* | 25 | 22 | 7 | 55 | 3 | 106 | 218 | 7.8 | 8.3 | 9.9 | 21.6 | 8.6 | 28.0 | 11.5 | 10.1 | 3.2 | 25.2 | 1.4 | 48.6 |
| *C. latipinnis* | 40 | 45 | 33 | 137 | 19 | 124 | 398 | 12.5 | 17.0 | 46.5 | 53.7 | 54.3 | 32.8 | 10.1 | 11.3 | 8.3 | 34.4 | 4.8 | 31.2 |
| *C. commersoni* x *discobolus* | 26 | 24 | 1 | 1 | -- | -- | 52 | 8.1 | 9.1 | 1.4 | .4 | -- | -- | 50.0 | 46.2 | 1.9 | 1.9 | -- | -- |
| *C. commersoni* x *latipinnis* | 5 | 19 | 7 | 11 | -- | -- | 42 | 1.6 | 7.2 | 9.9 | 4.3 | -- | -- | 11.9 | 45.2 | 16.7 | 26.2 | -- | -- |
| *C. discobolus* x *latipinnis* | 1 | 2 | 1 | 2 | -- | -- | 6 | .3 | .8 | 1.4 | .8 | -- | -- | 16.7 | 33.3 | 16.7 | 33.3 | -- | -- |
| *Ictalurus punctatus* | -- | -- | -- | 2 | 2 | 81 | 85 | -- | -- | -- | .8 | 5.7 | 21.4 | -- | -- | -- | 2.4 | 24 | 95.3 |
| Total | 320 | 264 | 71 | 255 | 35 | 378 | 1323 | | | | | | | | | | | | |

comprised a greater percentage of the total catch at the downstream stations. And, 3) the percentage of the total catch comprised by white suckers decreased with distance downstream. These three suckers and carp were the only species found in the electrofishing catch at all Yampa River sampling stations. Roundtail chubs, absent from electrofishing collections only at Station Y-1, occurred in the seine and dipnet samples from all stations.

Distribution and abundance of the less-abundant fishes in the electrofishing sample displayed the following major trends. Of the hybrid catostomids, those involving western white suckers (bluehead x white and flannelmouth x white sucker hybrids) were most abundant. The bluehead x flannelmouth sucker hybrid was far less abundant but was as widely distributed as hybrids between the white sucker and native suckers. Stations Y-2 and Y-2J yielded the highest cumulative percentage of hybrid and western white suckers, with the white sucker and its crosses comprising 55.31 and 22.86 percent of the total catch, respectively. At Station Y-3, only 6 river km below Station Y-2J, the white sucker and its hybrids comprised only 11.98 percent of the total catch. Mountain whitefish and rainbow trout were abundant only at Stations Y-1 and Y-2, and channel catfish were rare upstream from Station Y-3. Colorado squawfish were captured at Stations Y-2J, Y-3, Y-4a and in Juniper Springs Canyon (Table 12). Detailed descriptions of their captures and conditions under which they occurred are presented in Appendix I.

These major distributional trends were apparent in the yearly collections (Tables 13 through 15) with few exceptions. The high percent distribution of mountain whitefish at Station Y-1 in 1977 was the result of suspension of sampling at Station Y-2, where whitefish had been quite abundant. Total numbers of fish collected per year rose slightly during the study, perhaps because collecting became more efficient with increased experience.

Table 12. Summary of Colorado squawfish captures, 1975-1978

| Station | 1975 | | | | 1977 | | | | 1978 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | Length (mm) | Weight (g) | Age | Date | Length (mm) | Weight (g) | Age | Date | Length (mm) | Weight | Age |
| Y-2J | | | | | 6/27 | 472 | 1078 | 7 | 4/21 | 462 | 768 g | 6-7 |
| Juniper Springs Canyon | | | | | | | | | 10/12 | 500 | -- | 7 |
| | | | | | | | | | 10/12 | 610 | -- | 7-8 |
| | | | | | | | | | 10/12 | 510 | -- | 7 |
| | | | | | | | | | 10/12 | 820 | 12-14 lbs.est. | 10-11 |
| Y-3 | 8/7 | 506 | 1120 | -- | 4/22 | 539 | 1163 | -- | 4/21 | 630 | -- | 8 |
| | | | | | | | | | 4/21 | 510 | -- | 7-8 |
| | | | | | | | | | 4/21 | 515 | -- | 7 |
| | | | | | | | | | another fish positively identified but not captured | | | |
| Y-4a | 8/26 | 535 | 900 | 8 | | | | | 10/11 | 550 | -- | 7 |
| | 8/26 | 470 | 640 | 6 | | | | | 10/11 | 720 | 8-10 lbs. | 9 |
| | 8/26 | 635 | -- | 8-9 | | | | | | | | |
| W-A | | | | | 5/27 | 485 | 1362 | 7 | | | | |
| | | | | | 5/27 | 570 | | 8 | | | | |

Table 13. Summary of numbers of fishes collected by boat electrofishing from Yampa River in 1975 with percentage composition by station and percentage distribution by species.

| Station | Numbers Collected | | | | | | % Composition | | | | | % Distribution | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2J | Y-3 | Y-4a | Y-4 | All | Y-1 | Y-2J | Y-3 | Y-4a | Y-4 | Y-1 | Y-2J | Y-3 | Y-4a | Y-4 |
| *Prosopium williamsoni* | 29 | 7 | -- | -- | -- | 36 | 40.28 | 7.37 | -- | -- | -- | 80.56 | 19.44 | -- | -- | -- |
| *Salmo trutta* | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | .6 | -- | -- | -- | -- | 100 |
| *Cyprinus carpio* | -- | 2 | 7 | 2 | 10 | 21 | -- | 2.11 | 7.53 | 11.11 | 6.80 | -- | 9.50 | 33.30 | 9.50 | 47.62 |
| *Gila robusta* | -- | 4 | 6 | 2 | 3 | 15 | -- | 4.21 | 6.45 | 11.11 | 20.41 | -- | 26.67 | 40.00 | 13.33 | 20.00 |
| *Ptychocheilus lucius* | -- | -- | 1 | 3 | -- | 4 | -- | -- | 1.08 | 16.67 | -- | -- | -- | 25 | 75 | -- |
| *Catostomus commersoni* | 19 | 44 | 11 | -- | -- | 74 | 26.39 | 46.32 | 11.83 | -- | -- | 25.68 | 59.46 | 14.86 | -- | -- |
| *C. discobolus* | 4 | 12 | 9 | 2 | 45 | 72 | 5.5 | 12.63 | 9.68 | 11.11 | 30.61 | 5.5 | 16.67 | 12.5 | 2.78 | 62.5 |
| *C. latipinnis* | 11 | 18 | 56 | 7 | 43 | 135 | 15.28 | 18.95 | 60.22 | 38.89 | 79.25 | 8.15 | 13.33 | 41.48 | 5.19 | 31.85 |
| *C. discobolus* x *commersoni* | 8 | 6 | -- | -- | -- | 14 | 11.11 | 6.32 | -- | -- | -- | 57.15 | 42.86 | -- | -- | -- |
| *C. latipinnis* x *commersoni* | 1 | 2 | 1 | -- | -- | 4 | 13.88 | 2.11 | 1.08 | -- | -- | 25 | 50 | 25 | -- | -- |
| *Ictalurus punctatus* | -- | -- | 2 | 2 | 45 | 49 | -- | -- | 2.15 | 11.11 | 30.61 | -- | -- | 4.08 | 4.08 | 91.84 |
| Total | 72 | 95 | 93 | 18 | 147 | 425 | | | | | | | | | | |

Table 14. Summary of numbers of fishes collected by boat electrofishing from the Yampa River in 1976 with percentage composition by station and percentage distribution by species.

| Station | Numbers Collected | | | | | % Composition | | | | % Distribution | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2 | Y-3 | Y-4 | All | Y-1 | Y-2 | Y-3 | Y-4 | Y-1 | Y-2 | Y-3 | Y-4 |
| *Prosopium williamsoni* | 27 | 22 | 1 | -- | 50 | 29 | 17 | 1 | -- | 54 | 44 | 2 | -- |
| *Salmo gairdneri* | 1 | 9 | -- | -- | 10 | 1 | 7 | -- | -- | 10 | 90 | -- | -- |
| *Cyprinus carpio* | -- | -- | 4 | 15 | 19 | -- | -- | 5 | 11 | -- | -- | 21 | 79 |
| *Gila robusta* | -- | 1 | 5 | 12 | 18 | -- | 1 | 6 | 9 | -- | 6 | 28 | 67 |
| *Catostomus commersoni* | 41 | 55 | 5 | 2 | 103 | 45 | 42 | 6 | 1 | 40 | 53 | 5 | 2 |
| *C. discobolus* | 8 | 7 | 23 | 39 | 77 | 9 | 5 | 26 | 29 | 10 | 9 | 30 | 51 |
| *C. latipinnis* | 4 | 10 | 42 | 59 | 115 | 4 | 8 | 48 | 43 | 3 | 9 | 37 | 51 |
| *C. discobolus* x *commersoni* | 5 | 12 | 1 | -- | 18 | 5 | 9 | 1 | -- | 28 | 67 | 6 | -- |
| *C. discobolus* x *latipinnis* | -- | -- | 2 | -- | 2 | -- | -- | 2 | -- | -- | -- | 100 | -- |
| *C. latipinnis* x *commersoni* | -- | 12 | 5 | 1 | 18 | -- | 9 | 6 | 1 | -- | 67 | 28 | 6 |
| Unidentified Catostomidae | 5 | 3 | -- | -- | 8 | 5 | 2 | -- | -- | 63 | 37 | -- | -- |
| *Ictalurus punctatus* | -- | -- | -- | 8 | 8 | -- | -- | -- | 6 | -- | -- | -- | 100 |
| *Cottus bairdi* | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | 100 | -- | -- | -- |
| Total | 92 | 131 | 88 | 136 | 447 | | | | | | | | |

Table 15. Summary of numbers of fishes collected by boat electrofishing from the Yampa River in 1977 with percentage composition by station and percentage distribution by species.

| Station | Numbers Collected | | | | | % Composition | | | | % Distribution | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2J | Y-3 | Y-4* | All | Y-1 | Y-2J | Y-3 | Y-4 | Y-1 | Y-2J | Y-3 | Y-4 |
| *Prosopium williamsoni* | 42 | 2 | -- | -- | 44 | 26 | 1 | -- | -- | 95 | 5 | -- | -- |
| *Salmo gairdneri* | 6 | -- | -- | -- | 6 | 4 | -- | -- | -- | 100 | -- | -- | -- |
| *Cyprinus carpio* | -- | 11 | 2 | 22 | 35 | -- | 7 | 2 | 12 | -- | 31 | 6 | 63 |
| *Gila robusta* | -- | 9 | 2 | 16 | 27 | -- | 6 | 2 | 9 | -- | 33 | 7 | 59 |
| *Ptychocheilus lucius* | -- | 1 | 1 | -- | 2 | -- | 1 | 1 | -- | -- | 50 | 50 | -- |
| *Catostomus commersoni* | 44 | 21 | 7 | 1 | 73 | 27 | 14 | 8 | 1 | 60 | 29 | 10 | 1 |
| *C. discobolus* | 19 | 19 | 33 | 38 | 109 | 12 | 13 | 36 | 21 | 17 | 17 | 30 | 35 |
| *C. latipinnis* | 29 | 60 | 43 | 74 | 206 | 18 | 40 | 47 | 41 | 14 | 29 | 21 | 36 |
| *C. discobolus* x *commersoni* | 14 | 10 | 2 | -- | 26 | 9 | 7 | 2 | -- | 54 | 38 | 8 | -- |
| *C. discobolus* x *latipinnis* | 1 | 1 | -- | -- | 2 | 1 | 1 | -- | -- | 50 | 50 | -- | -- |
| *C. latipinnis* x *commersoni* | 6 | 15 | 2 | -- | 23 | 4 | 10 | 2 | -- | 26 | 65 | 9 | -- |
| Unidentified Catostomidae | -- | 1 | -- | -- | 1 | -- | 1 | -- | -- | -- | 100 | -- | -- |
| *Ictalurus punctatus* | -- | -- | -- | 29 | 29 | -- | -- | -- | 16 | -- | -- | -- | 100 |
| Total | 161 | 150 | 92 | 180 | 583 | | | | | | | | |

*Station 4 combined with 4a.

Eight species of fish and one hybrid were collected by electrofishing from the White River (Table 16). Again, flannelmouth suckers comprised the greatest percentage of the catch at all (both) stations. Bluehead suckers were second in abundance. Roundtail chubs were common at both stations, but mountain whitefish occurred only at Station W-A. While channel catfish occurred in many collections from Station W-B, they were captured only during the extreme low-flow period of 1977 at Station W-A (Appendix II). Two bluehead x flannelmouth sucker hybrids were captured at Station W-A; they were the only known or suspected hybrid fish collected by electrofishing from the White River. Colorado squawfish were collected at Station W-A in 1977 (Table 12 and Appendix I).

Seine and dipnet collections

Of 14,373 specimens collected from the seven Yampa River collecting trips in 1976, redside shiners made up 32%, speckled dace 17%, bluehead suckers 12% and flannelmouth suckers 11% of the catch (Table 17). In 1977, 5,634 fish were collected by seine and dipnet during 18 Yampa River collections (Table 18). Predominant species were fathead minnows (24%), redside shiners (19%), flannelmouth suckers (16%), speckled dace (11%), and bluehead suckers (10%). Results of each collection trip were tabulated by station (Appendix II).

Table 16. Summary of fishes collected by electrofishing from the White River, July 1975 through October 1977, with percentage composition by station and percentage distribution by species.

| Station | Numbers collected | | % Composition | | % Distribution | |
|---|---|---|---|---|---|---|
| | W-A | W-B | W-A | W-B | W-A | W-B |
| Prosopium williamsoni | 24 | -- | 13.04 | -- | 100 | -- |
| Cyprinus carpio | 5 | 4 | 2.72 | 2.96 | 55.55 | 44.45 |
| Gila robusta | 10 | 22 | 5.43 | 16.3 | 45.5 | 54.5 |
| Ptychocheilus lucius | 2 | -- | 1.09 | -- | 100 | -- |
| Catostomus discobolus | 18 | 7 | 9.78 | 5.19 | 72 | 28 |
| C. latipinnis | 121 | 98 | 65.76 | 72.59 | 55.3 | 44.7 |
| C. discobolus x latipinnis | 2 | -- | 1.08 | -- | 100 | -- |
| Ictalurus punctatus | 2 | 3 | 1.09 | 2.22 | 40 | 60 |
| I. melas | -- | 1 | -- | .7 | -- | 100 |
| Total | 184 | 135 | | | | |

Table 17. Summary of numbers of fishes collected by seine and dipnet from the Yampa River in 1976 with percentage composition by station and percentage distribution by species.

| Station | Numbers collected | | | | | | | % Composition | | | | | | | % Distribution[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2 | Y-2a to Y-2f[a] | Y-3 | Y-4 | Y-4a[b] | All | Y-1 | Y-2 | Y-2a to Y-2f[a] | Y-3 | Y-4 | Y-4a[b] | All | Y-1 | Y-2 | Y-3 | Y-4 |
| *Prosopium williamsoni* | 46 | 47 | 1 | 4 | -- | -- | 98 | 2 | 2 | * | d | -- | -- | 1 | 47 | 48 | 4 | -- |
| *Cyprinus carpio* | -- | -- | 2 | 162 | 1 | -- | 165 | -- | -- | * | 3 | * | -- | 1 | -- | -- | 99 | 1 |
| *Gila robusta* | 184 | 48 | 47 | 384 | 160 | 34 | 857 | 8 | 2 | 4 | 6 | 10 | 30 | 6 | 24 | 6 | 49 | 21 |
| *Notropis stramineus* | -- | -- | 2 | 405 | 44 | 6 | 457 | -- | -- | * | 7 | 2 | 5 | 3 | -- | -- | 90 | 10 |
| *Pimephales promelas* | 153 | 644 | 403 | 103 | 6 | 5 | 1314 | 7 | 24 | 34 | 2 | * | 4 | 9 | 17 | 71 | 11 | 1 |
| *Rhinichthys osculus* | 316 | 283 | 109 | 1100 | 612 | 13 | 2433 | 14 | 11 | 9 | 18 | 28 | 12 | 17 | 14 | 12 | 48 | 26 |
| *Richardsonius balteatus* | 724 | 798 | 228 | 1933 | 828 | 25 | 4536 | 32 | 30 | 19 | 32 | 37 | 22 | 32 | 17 | 19 | 45 | 19 |
| *Semotilus atromaculatus* | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | 1 | d | -- | -- | -- | -- |
| *R. osculus* x *R. balteatus*? | 3 | 3 | -- | 3 | -- | -- | 9 | * | * | -- | * | -- | -- | d | 33 | 33 | 33 | -- |
| *Catostomus commersoni* | 251 | 346 | 89 | 100 | 5 | 4 | 795 | 11 | 13 | 8 | 2 | * | 4 | 6 | 36 | 49 | 14 | 1 |
| *C. discobolus* | 342 | 281 | 107 | 693 | 332 | 1 | 1756 | 15 | 11 | 9 | 12 | 15 | 1 | 12 | 21 | 17 | 42 | 20 |
| *C. latipinnis* | 91 | 120 | 63 | 1070 | 177 | 24 | 1545 | 4 | 5 | 5 | 18 | 8 | 21 | 11 | 6 | 8 | 73 | 12 |
| *C. discobolus* x *commersoni* | -- | -- | -- | 3 | 1 | -- | 4 | -- | -- | -- | * | * | -- | d | -- | -- | 75 | 25 |
| *C. latipinnis* x *commersoni* | -- | -- | -- | 2 | -- | -- | 2 | -- | -- | -- | * | -- | -- | d | -- | -- | 100 | -- |
| Unidentified Catostomidae | 102 | 65 | 123 | 26 | 7 | -- | 323 | 5 | 2 | 10 | * | * | -- | 2 | 51 | 33 | 13 | 4 |
| *Fundulus kansae* | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | * | -- | -- | d | -- | -- | 100 | -- |
| *Cottus bairdi* | 20 | 13 | 6 | -- | 38 | -- | 77 | 1 | * | 1 | -- | 2 | -- | 1 | 28 | 18 | -- | 54 |
| Total | 2232 | 2648 | 1180 | 5989 | 2211 | 113 | 14373 | | | | | | | | 17 | 20 | 46 | 17 |

*Percentage less than 0.5.
[a]This section sampled on canoe float trip 16-19 August.
[b]This station at mouth of Cross Mountain Canyon sampled 4-6 and 19 August.
[c]% distribution based on fish collected at Stations 1, 2, 3 and 4 only.

Table 18. Summary of numbers of fishes collected by seine and dipnet from the Yampa River in 1977 with percentage composition by station and percentage distribution by species.

| Station | Numbers Collected | | | | | | % Composition | | | | | | % Distribution[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2J | Y-3 | Y-4 | Y-4a[a] | All | Y-1 | Y-2J | Y-3 | Y-4 | Y-4a | All | Y-1 | Y-2J | Y-3 | Y-4 |
| *Prosopium williamsoni* | 27 | -- | -- | -- | -- | 27 | 2 | -- | -- | -- | -- | * | 100 | -- | -- | -- |
| *Cyprinus carpio* | -- | 4 | 17 | 3 | -- | 24 | -- | * | -- | * | -- | * | -- | 17 | 71 | 13 |
| *Gila robusta* | 123 | 53 | 105 | 22 | 15 | 318 | 9 | 4 | -- | 2 | 9 | 6 | 41 | 17 | 35 | 7 |
| *Notropis stramineus* | -- | -- | 120 | 50 | 10 | 180 | -- | -- | 8 | 5 | 6 | 3 | -- | -- | 71 | 29 |
| *Pimephales promelas* | 333 | 419 | 564 | 20 | 17 | 1353 | 24 | 28 | 37 | 2 | 10 | 24 | 25 | 31 | 42 | 1 |
| *Rhinichthys osculus* | 66 | 241 | 135 | 140 | 61 | 643 | 5 | 16 | 9 | 13 | 37 | 11 | 11 | 41 | 23 | 24 |
| *Richardsonius balteatus* | 250 | 199 | 137 | 495 | 2 | 1083 | 18 | 13 | 9 | 46 | 1 | 19 | 23 | 18 | 13 | 46 |
| *R. osculus* x *R. balteatus?* | 1 | -- | -- | -- | -- | 1 | * | -- | -- | -- | -- | * | 100 | -- | -- | -- |
| *Catostomus commersoni* | 440 | 26 | 23 | 7 | 6 | 502 | 32 | 2 | 2 | 1 | 4 | 9 | 89 | 5 | 5 | 1 |
| *C. discobolus* | 111 | 212 | 93 | 128 | 8 | 552 | 8 | 14 | 6 | 12 | 5 | 10 | 20 | 39 | 17 | 24 |
| *C. latipinnis* | 39 | 328 | 308 | 199 | 43 | 917 | 3 | 22 | 20 | 19 | 26 | 16 | 4 | 38 | 35 | 23 |
| *C. discobolus* x *commersoni* | -- | -- | 7 | -- | -- | 7 | -- | -- | * | -- | -- | * | -- | -- | 100 | -- |
| *C. latipinnis* x *commersoni* | 1 | -- | 5 | -- | 1 | 7 | * | -- | * | -- | 1 | * | 17 | -- | 83 | -- |
| *Ictalurus melas* | -- | 2 | -- | -- | -- | 2 | -- | * | -- | -- | -- | * | -- | 100 | -- | -- |
| *Cottus bairdi* | 3 | 3 | 4 | 6 | 2 | 18 | * | * | * | 1 | 1 | * | 19 | 19 | 25 | 38 |
| Total | 1394 | 1487 | 1518 | 1070 | 165 | 5634 | | | | | | | 25 | 27 | 28 | 20 |

*Percentage less than .5.
[a]Station sampled only once, 22 July.
[b]% Distribution based on fish collected at Stations 1, 2J, 3 and 4 only.

The most notable change in collections over the 2 years was the increase in fathead minnows from 9% of collections made in 1976 to 24% of those in 1977. Redside shiners declined from 32% to 19% of the catch during the same period. Speckled dace declined slightly from 1976 to 1977, while flannelmouth suckers increased slightly. All of the above changes can probably be attributed to extremely-low water levels in 1977, which favored species tolerant of low velocities and high temperatures.

In 1976, seine and dipnet collections on the White River yielded 2,430 fish. The predominant species collected (Table 19) were speckled dace (39%), flannelmouth suckers (26%), and bluehead suckers (22%). Seine and dipnet samples from the White River in 1977 yielded 743 fish. Speckled dace made up 39%, flannelmouth suckers 28%, roundtail chubs 12%, and bluehead suckers 11% of the collection (Table 20).

Species composition remained fairly stable on the White River throu- out the collection period. Roundtail chubs increased from 5% of the catch in 1976 to 12% in 1977, while bluehead suckers decreased from 22 to 11% over the same period.

## Plankton-net collections

Seventeen collections yielded only 38 eggs, larvae or juveniles representing at least four species. The results indicated some downstream drift of speckled dace, bluehead suckers and flannelmouth suckers.

## Special 1978 collections

Fish sampling in 1978 was geared to Colorado Division of Wildlife interest in endangered fish distribution and our own interest in developing

Table 19. Summary of numbers of fishes collected by seine and dipnet from the White River in 1976 with percentage composition by station and percentage distribution by species.

| Station | Numbers Collected | | | % Composition | | | % Distribution | |
|---|---|---|---|---|---|---|---|---|
| | W-A | W-B | All | W-A | W-B | All | W-A | W-B |
| *Prosopium williamsoni* | 88 | -- | 88 | 7 | -- | 4 | 100 | -- |
| *Cyprinus carpio* | 4 | 7 | 11 | * | 1 | * | 36 | 64 |
| *Gila robusta* | 78 | 32 | 110 | 6 | 3 | 5 | 71 | 29 |
| *Notropis lutrensis* | -- | 1 | 1 | -- | * | * | -- | 100 |
| *Pimephales promelas* | 53 | 15 | 68 | 4 | 1 | 3 | 78 | 22 |
| *Rhinichthys osculus* | 337 | 614 | 951 | 27 | 52 | 39 | 35 | 65 |
| *Catostomus discobolus* | 441 | 86 | 527 | 35 | 7 | 22 | 84 | 16 |
| *C. latipinnis* | 228 | 392 | 620 | 18 | 33 | 26 | 37 | 63 |
| *C. platyrhynchus* | 1 | -- | 1 | * | -- | * | 100 | -- |
| *Cottus bairdi* | 14 | 39 | 53 | 1 | 3 | 2 | 26 | 74 |
| Total | 1244 | 1186 | 2430 | | | | 51 | 49 |

*Percentage less than .5.

Table 20. Summary of numbers of fishes collected by seine and dipnet from the White River in 1977 with percentage composition by station and percentage distribution by species.

| Station | Numbers collected | | | % Composition | | | % Distribution | |
|---|---|---|---|---|---|---|---|---|
| | W-A | W-B | All | W-A | W-B | All | W-A | W-B |
| *Prosopium williamsoni* | 1 | -- | 1 | * | -- | * | 100 | -- |
| *Cyprinus carpio* | 20 | 3 | 23 | 5 | 1 | 3 | 87 | 13 |
| *Gila robusta* | 68 | 24 | 92 | 17 | 7 | 12 | 74 | 26 |
| *Notropis lutrensis* | 3 | 14 | 17 | 1 | 4 | 2 | 18 | 82 |
| *Pimephales promelas* | 16 | 8 | 24 | 4 | 2 | 3 | 67 | 33 |
| *Rhinichthys osculus* | 157 | 132 | 289 | 40 | 38 | 39 | 54 | 46 |
| *Catostomus discobolus* | 63 | 20 | 83 | 16 | 6 | 11 | 76 | 24 |
| *C. latipinnis* | 59 | 148 | 207 | 15 | 42 | 28 | 29 | 71 |
| *Cottus bairdi* | 5 | 2 | 7 | 1 | 1 | 1 | 71 | 29 |
| Total | 392 | 351 | 743 | | | | 53 | 47 |

*Percentage less than .5.

larval series of selected Yampa and White River fishes. Squawfish were collected on 21 April at Station Y-3 near Maybell (Appendix I). All appeared to be in good condition and were released. These and other collections on 21 and 22 April by electrofishing are summarized in Table 21. Suckers collected on 21 April were not ripe.

The Round Bottom area below Craig was sampled extensively during late afternoon and night-time hours on 20 May. Neither endangered fishes nor running-ripe suckers were collected, but several heavily-tuberculated male suckers were noted (Table 21).

On June 1, running-ripe flannelmouth suckers were captured at Station Y-2J. Spawning suckers were congregated below the downstream tips of islands. The water depth at the point of collection was 0.5-1.5 m over gravel substrate. Water velocities below the islands were lower than mainstream levels and were variable because of eddies created by the islands. Fish captured below one island were actively spawning; eggs and milt were exuded from the fish while they were being netted. Larvae cultured from the gametes were preserved; the developmental series is available at CSU-DFWB. No running-ripe bluehead suckers were collected.

On June 25, a special trip was made to Station W-A on the White River to collect bluehead sucker gametes. Ripe bluehead suckers were collected in shallow riffle areas over gravel and cobble substrates. Water depths varied between 0.5 and 1.0 m. Most female bluehead suckers were not running ripe, but gametes were successfully taken from one and artificially fertilized. A developmental series was cultured and preserved.

Six Colorado squawfish were collected on October 11-12 from Cross Mountain and Juniper Springs Canyons. Data on their capture are presented with permission of the Colorado Division of of Wildlife (Table 12, Appendix I).

Table 21. Numbers of fishes collected by electrofishing on Yampa and White Rivers, 1978.

| Date | April | | | | May | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | 21 | 22 | 22 | 20 | 21 | 21 | 31 | 31 | 31 |
| Station | Y-2J | Y-3 | Y-4 | W-A | Round Bottom | Y-2J | Y-3 | Y-4 | W-A | W-B |
| *Prosopium williamsoni* | 2 | -- | -- | 35 | 19 | -- | -- | -- | 3 | -- |
| *Salmo trutta* | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| *S. gairdneri* | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| *Cyprinus carpio* | 2 | -- | 8 | 3 | -- | -- | -- | -- | -- | -- |
| *Gila robusta* | 1 | -- | 4 | 2 | 7 | 8 | -- | 3 | 4 | 4 |
| *Ptycocheilus lucius* | 1 | 3* | -- | -- | -- | -- | -- | -- | -- | -- |
| *Catostomus commersoni* | -- | -- | -- | -- | 42 | 9 | -- | -- | -- | -- |
| *C. discobolus* | 3 | 4 | -- | 3 | 3 | 3 | -- | 1 | 6 | 1 |
| *C. latipinnis* | 19 | 9 | 38 | 32 | 37 | 25 | 9 | 18 | 42 | 24 |
| Hybrid suckers | 1 | 2 | -- | -- | 5 | 2 | 8 | -- | -- | -- |
| Total | 29 | 18 | 50 | 76 | 114 | 47 | 17 | 22 | 55 | 29 |

*One additional squawfish positively identified but not captured.

Mean length comparisons

Because of disparate sample sizes from different stations, only the more abundant species in the Yampa River electrofishing collections were analyzed for trends in mean length with downstream distance (Stations Y-1 to Y-4). In a regression analysis of bluehead sucker mean length vs. station (Y-1=1, Y-4=6), a distinct trend toward decreased length at lower elevation was noted (Table 22). Similar but less-pronounced decreases in mean length with station were noted for flannelmouth and white suckers and roundtail chubs.

Age and growth

Length-frequency histograms (Appendix IV) were examined for dominant and secondary peaks, the values and ranges of which were compiled in Table 23. For mountain whitefish, white suckers, bluehead suckers and flannelmouth suckers, those peaks were compared with age classes determined by scale and pectoral fin ray analysis (Tables 24-26).

Mountain whitefish at Stations Y-1 and Y-2 occurred in equal numbers at 260 and 300-mm length intervals, which corresponded closely to lengths of scale-aged fish 5 and 6 years old, respectively. White suckers showed similar growth patterns, with the most abundant length classes corresponding to lengths of 5- and 6-year-old scale-aged fish. Length at the secondary frequency peak for white suckers roughly correponded with lengths of 3- or 4-year-old scale-aged fish.

Age-length correspondence for flannelmouth and bluehead suckers was less apparent, perhaps because of the small length differences among older age classes, especially prominent in the analysis of flannelmouth suckers. The most abundant length-class of flannelmouth suckers corresponded with the length of scale- and ray-aged fish 9 and 10 years old collected in 1976 at the

Table 22. Mean length (mm) of fishes collected from Yampa River Stations Y-1 through Y-4, July 1975 through October 1977, with associated regression parameters (slope and correlation coefficient, R).

| Species | Station | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Y-1 | Y-2 | Y-2J | Y-3 | Y-4a | Y-4 | Slope | R |
| *Gila robusta* | -- | 342 | 328 | 259 | 211 | 286 | -22.90 | -.68 |
| *Catostomus discobolus* | 361 | 341 | 313 | 318 | 299 | 312 | -10.45 | -.86 |
| *C. latipinnis* | 459 | 351 | 425 | 421 | 336 | 364 | -14.97 | -.57 |
| *C. commersoni* | 303 | 316 | 358 | 288 | 195 | 191 | -28.37 | -.78 |

Table 23. First and second dominant size classes (by frequency) for selected Yampa and White River fishes (from Appendix IV).

| Species | Station | Year | First dominant size (mm) n | mean | range | 2nd dominant size (mm) n | mean | range |
|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | Y-1 | 1975 | 3 | 261 | 243-280 | 3 | 293 | 275-312 |
| | | 1976 | 3 | 268 | 240-284 | 3 | 301 | 284-310 |
| | Y-2 | 1976 | 4 | 275 | 263-309 | 3 | 251 | 241-274 |
| *Catostomus discobolus* | Y-3 | 1976 | 3 | 331 | 324-338 | 3 | 373 | --- |
| | | 1977 | 4 | 358 | 335-380 | 3 | 322 | 299-344 |
| | Y-4 | 1975 | 10 | 343 | 322-365 | 6 | 300 | 289-322 |
| | | 1976 | 5 | 317 | 394-335 | 5 | 352 | 339-364 |
| *C. latipinnis* | Y-1 | 1977 | 5 | 497 | 480-514 | 4 | 464 | 440-472 |
| | Y-2J | 1977 | 6 | 423 | 386-452 | 3 | 481 | 452-490 |
| | Y-3 | 1975 | 10 | 436 | 400-463 | 9 | 482 | 480-490 |
| | | 1976 | 9 | 451 | 366-488 | 1 | 257 | --- |
| | | 1977 | 7 | 438 | 310-467 | 2 | 266 | --- |
| | Y-4 | 1975 | 6 | 386 | 358-427 | 4 | 331 | 317-372 |
| | | 1976 | 9 | 382 | 351-428 | 7 | 350 | 321-366 |
| | | 1977 | 4 | 329 | 316-340 | 3 | 414 | 377-424 |
| | W-A | 1976 | 6 | 301 | 251-366 | 2 | 236 | --- |
| | W-A | 1977 | 8 | 445 | 314-402 | 7 | 358 | 417-490 |
| *C. commersoni* | Y-1 | 1976 | 6 | 346 | 311-364 | 4 | 216 | --- |
| | | 1977 | 7 | 300 | 267-362 | 5 | 237 | 221-284 |
| | Y-2 | 1975 | 8 | 329 | 290-395 | 6 | 233 | 218-275 |
| | | 1976 | 8 | 355 | 287-440 | 3 | 185 | 168-219 |
| *Ictalurus punctatus* | Y-4 | 1975 | 8 | 317 | 225-420 | 3 | 440 | 420-470 |
| | | 1977 | 6 | 296 | 280-325 | 3 | 353 | 325-370 |

Table 24. Age (from scale analysis) and mean length data for White and Yampa River suckers, 1976.

| Species | Yampa River Age | Yampa River No. | Yampa River Range of length | Yampa River Average length | White River Age | White River No. | White River Range of length | White River Average length |
|---|---|---|---|---|---|---|---|---|
| *Catostomus latipinnis* | 10 | 3 | 370-492 | 450 | 10 | 1 | --- | 485 |
| | 9 | 2 | 435-456 | 445 | 9 | 2 | 445-452 | 449 |
| | 8 | 3 | 358-416 | 383 | 8 | 4 | 286-415 | 394 |
| | 7 | - | --- | - | 7 | 2 | 315-378 | 347 |
| | 6 | 2 | 340-342 | 341 | 6 | 3 | 276-356 | 325 |
| | 5 | 2 | 259-302 | 281 | 5 | 3 | 255-331 | 289 |
| | 4 | 3 | 244-252 | 247 | 4 | 2 | 236-245 | 241 |
| | 3 | 1 | --- | 180 | 3 | 1 | --- | 225 |
| | | | | | 2 | 2 | 126-160 | 143 |
| *C. discobolus* | 7 | 5 | 304-385 | 353 | 9 | 1 | --- | 401 |
| | 6 | 13 | 276-359 | 324 | 8 | 1 | --- | 430 |
| | 5 | 6 | 232-378 | 305 | 7 | 1 | --- | 360 |
| | 4 | 1 | --- | 220 | 6 | 3 | 332-368 | 340 |
| | | | | | 4 | 2 | 245-273 | 259 |
| *C. latipinnis* x *C. commersoni* | 8 | 2 | 432-512 | 472 | | | | |
| | 7 | 1 | --- | 455 | | | | |
| | 6 | 4 | 384-430 | 397 | | | | |
| | 4 | 1 | --- | 272 | | | | |
| | 2 | 2 | 182-215 | 199 | | | | |
| *C. discobolus* x *C. commersoni* | 7 | 5 | 350-434 | 388 | | | | |
| | 6 | 4 | 357-400 | 384 | | | | |
| | 5 | 2 | 365-368 | 367 | | | | |
| | 4 | 4 | 270-307 | 290 | | | | |
| | 3 | 1 | --- | 256 | | | | |

Table 25. Growth of mountain whitefish, *Prosopium williamsoni*, in the Yampa River based on scale analysis.

| Year class | No. | Back-calculated total length (mm) at annulus | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII |
| 1974 | 3 | 120 | | | | | | |
| 1973 | 1 | 114 | 176 | | | | | |
| 1972 | 5 | 123 | 161 | 217 | | | | |
| 1971 | 3 | 115 | 150 | 208 | 243 | | | |
| 1970 | 5 | 119 | 150 | 187 | 226 | 251 | | |
| 1969 | 3 | 120 | 155 | 199 | 234 | 257 | 287 | |
| 1968 | 3 | 124 | 155 | 198 | 232 | 259 | 288 | 305 |
| Weighted mean | | 120 | 156 | 202 | 233 | 255 | 288 | 305 |
| No. fish | | 23 | 20 | 19 | 14 | 11 | 6 | 3 |

Table 26. Growth of white sucker, *Catostomus commersoni*, in the Yampa River based on scale analysis.

| Year class | No. | Back-calculated total length (mm) at annulus* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | II | III | IV | V | VI | VII | VIII |
| 1973 | 5 | 116 | 177 | | | | | |
| 1972 | 4 | 122 | 183 | 240 | | | | |
| 1971 | 5 | 125 | 183 | 250 | 288 | | | |
| 1970 | 2 | 130 | 185 | 250 | 290 | 333 | | |
| 1969 | 3 | 111 | 154 | 217 | 265 | 303 | 341 | |
| 1968 | 2 | 144 | 204 | 290 | 318 | 345 | 364 | 378 |
| Weighted mean | | 123 | 180 | 246 | 288 | 324 | 350 | 378 |
| No. fish | | 21 | 21 | 16 | 12 | 7 | 5 | 2 |

*No distinct first annulus could be detected.

upper Yampa River stations. The previously-noted tendency toward reduction in mean length with downstream sampling station was also apparent in the frequency analysis for flannelmouth suckers (Appendix IV). The flannelmouth sucker sample from the White River exhibited a more normalized distribution pattern with good representation of lengths corresponding to those of fish aged 4, 6, 7 and 9 years by scales and pectoral rays.

The bluehead sucker sample was composed predominantly of fish in the scale-aged length classes corersponding to ages 6 and 7. Even the secondary frequency peak was at a length corresponding to lengths of fish at least 6 years old.

Colorado squawfish collected from 1975 through 1978 were aged by scale analysis. Squawfish lengths, weights and estimated ages were included in Table 12.

Cumulative statistics (including lengths and K) for all fishes collected by electrofishing at each station from 1975 through 1977 are presented in Appendix V.

Spawning times

Spawning information (Figures 5 and 6) for 1976 and 1977 for each river was developed from length-frequency distribution tables for each species (Appendix III) and a review of selected literature (Table 27). Temperature and flow data for both years are provided for comparative purposes (Figures 7-12).

Spawning on the Yampa and White Rivers took place earlier in 1977 than in 1976. Because of the low discharge and high water temperatures that occurred early in 1977, 1976 results should be considered more typical. Peak spawning seasons of most species were often over a month in duration, and extended seasons frequently spanned 2 months.

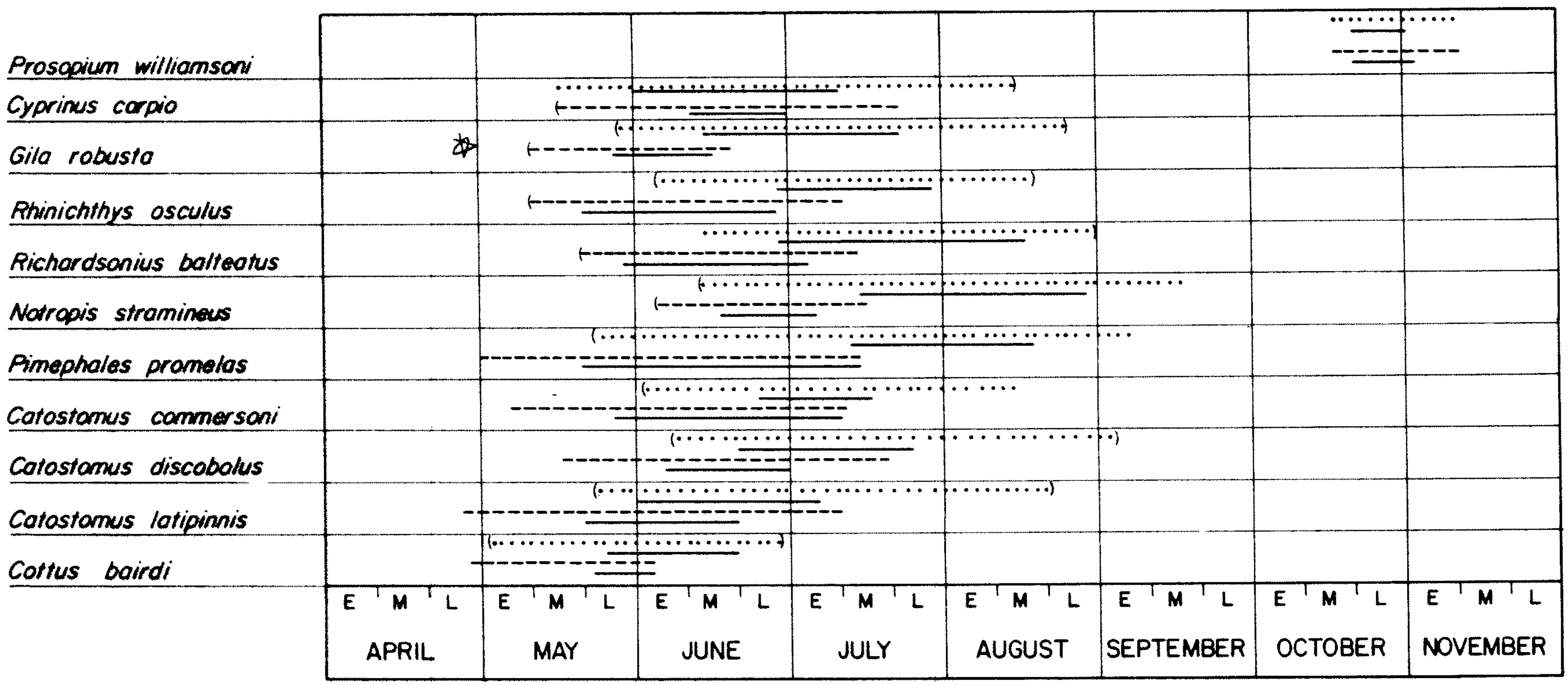



Figure 5. Spawning seasons of Yampa River fishes derived from length frequency data 1976 and 1977. Dots · · · represent 1976 spawning season, dashes - - - represent 1977 spawning season, and parentheses indicate observed bounds to spawning period. Solid lines under extended annual spawning seasons represent principal spawning period for that year.

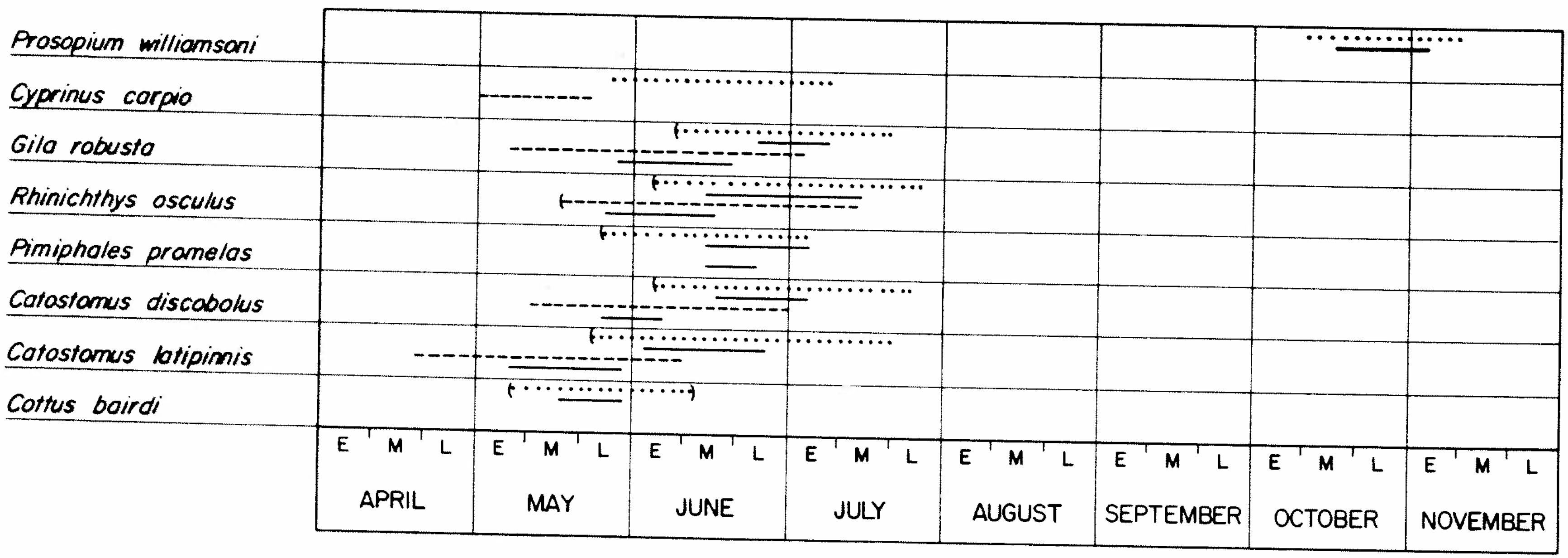



Figure 6. Spawning seasons of the White River fishes derived from length frequency data 1976 and 1977. Dots . . . represent the 1976 spawning season, dashes - - - represent the 1977 spawning season, solid lines under extended annual spawning seasons represent principal spawning period for that year, and parentheses indicate observed bounds to spawning period.

Table 27. Selected reproductive and early life history information.

| Species | Size at hatching (mm) | Incubation time & temp. | Historical spawning times | Spawning temp. | References |
|---|---|---|---|---|---|
| Prosopium williamsoni | 12 | 5 mo 35 F<br>1 mo 48 F | October - November | 7 C | Daily (1971) |
| Cyprinus carpio | 3-6.4 | 3-5 days 20 C<br>5 days 15 C | April - August (intermittent) | 18-22 C opt.<br>10-30 C range | Mansueti & Hardy (1967) |
| Gila robusta | 7* | 6-8 days est.* | June - July | 65 F | Vanicek and Kramer (1969) |
| Rhinichthys osculus | 4.5-6.2[a] | 5 days 16 C | June | 12-18 C | Fuiman L. A. and J. J. Loos (1977) |
| Richardsonius balteatus | [illegible]-5.5 | 3-7 days 20-23 C (cultured)<br>5-10 est. in nature | May - July Montana | 9-15 C | Weisel and Newman (1951) |
| Notropis stramineus | 5 est.* | 6 days est. | May - August | 21-37 C<br>31 C opt. | Summerfelt & Minckly (1969) |
| Pimephales promelas | 4.5 | 4.5-6 days | May - August | 17 C<br>12.8-18 C in Colorado | Dobie et al. (1956), Snyder et al. (1977), Andrews and Flickinger (1973) |
| Catostomus commersoni | 8-9<br>up to 12 | 7 days 57-68 F<br>10-15 days 50-60 F | May - June | 11-16 C | Fuiman (1978), Long and Ballard (1976), Dobie et al. (1956) |
| C. discobolus | 10-11* | 7-8 days 60-64 F * | June | 6-8 C Utah<br>15-18 C Yampa | Andreasen and Barnes (1975), Holden (1973) |
| C. latipinnis | 11-12* | 6-7 days 60-64 F | May - June | 6-12 C | McAda (1977) |
| Cottus bairdi | 7 est.[b] | 21-28 days est. | February - June | 6-16 C | Fish (1932), Simon & Brown (1943), Bailey (1952) |

[a]Information pertains to *Rhinichthys atratulus*.

*Present study.

[b]Some information pertains to *Cottus semiscaber*.

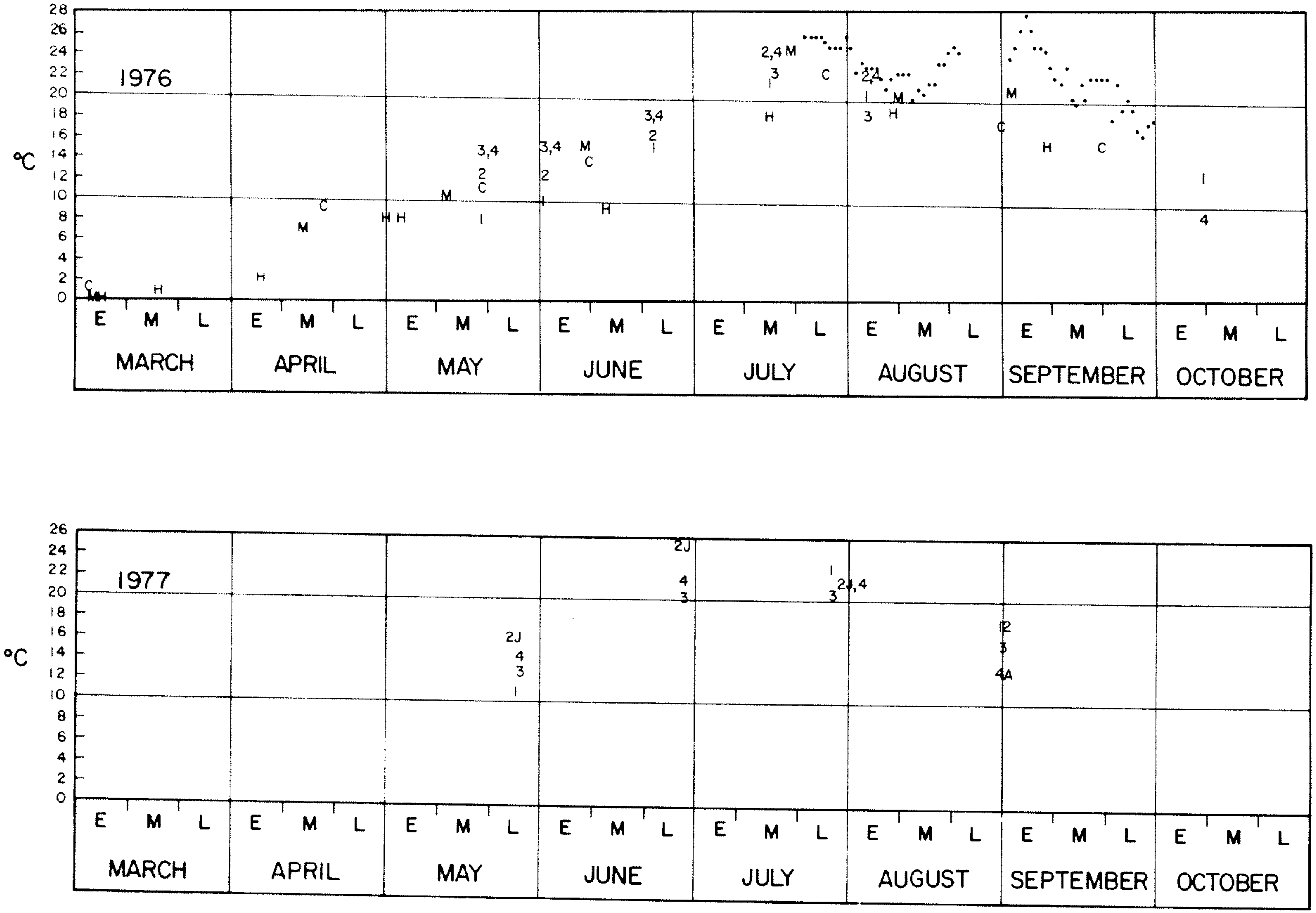



Figure 7. Recorded daytime temperatures on the Yampa River at Stations Y-1, Y-2, Y-2J (in 1977), Y-3, and Y-4. Data for Hayden (H), Craig (C), and Maybell (M) based on USGS data. Dots represent USGS recorded daily maxima at Maybell 1976.

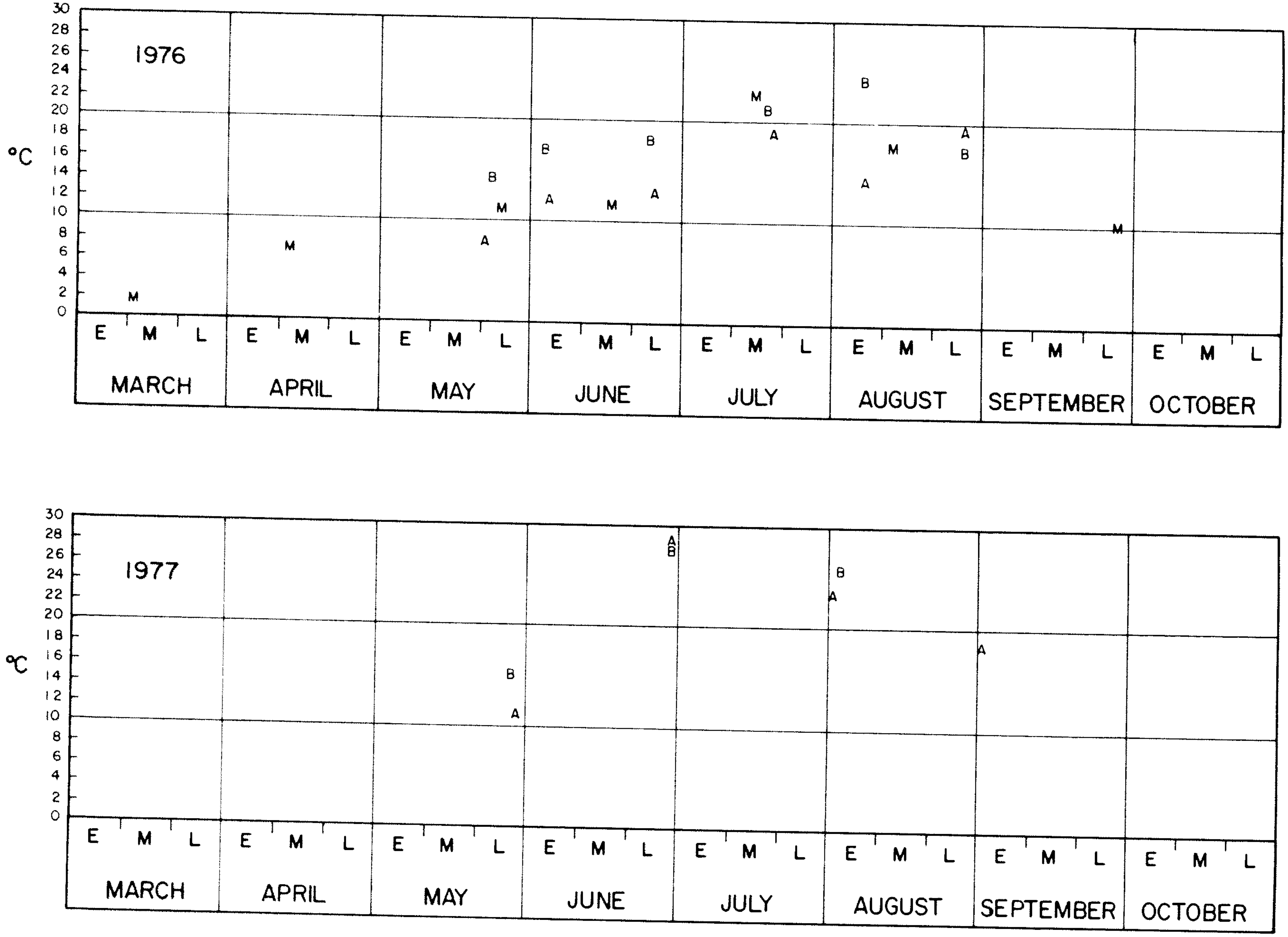



Figure 8. Recorded daytime temperatures on the White River, 1976 and 1977, at Stations W-A and W-B and below Meeker (M) (USGS 1976 data).

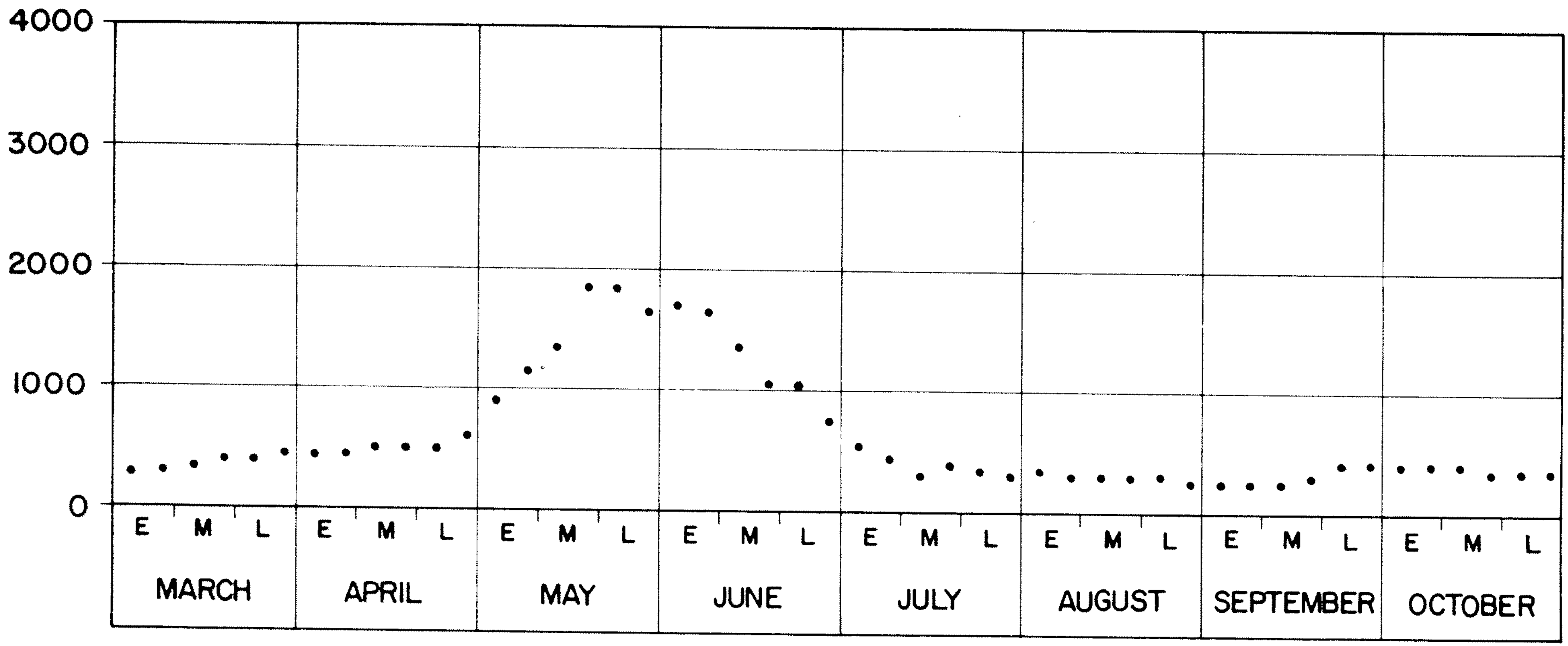



Figure 9. USGS flow data averaged over 5-day intervals to the nearest 50 cfs for White River below Meeker, 1976.

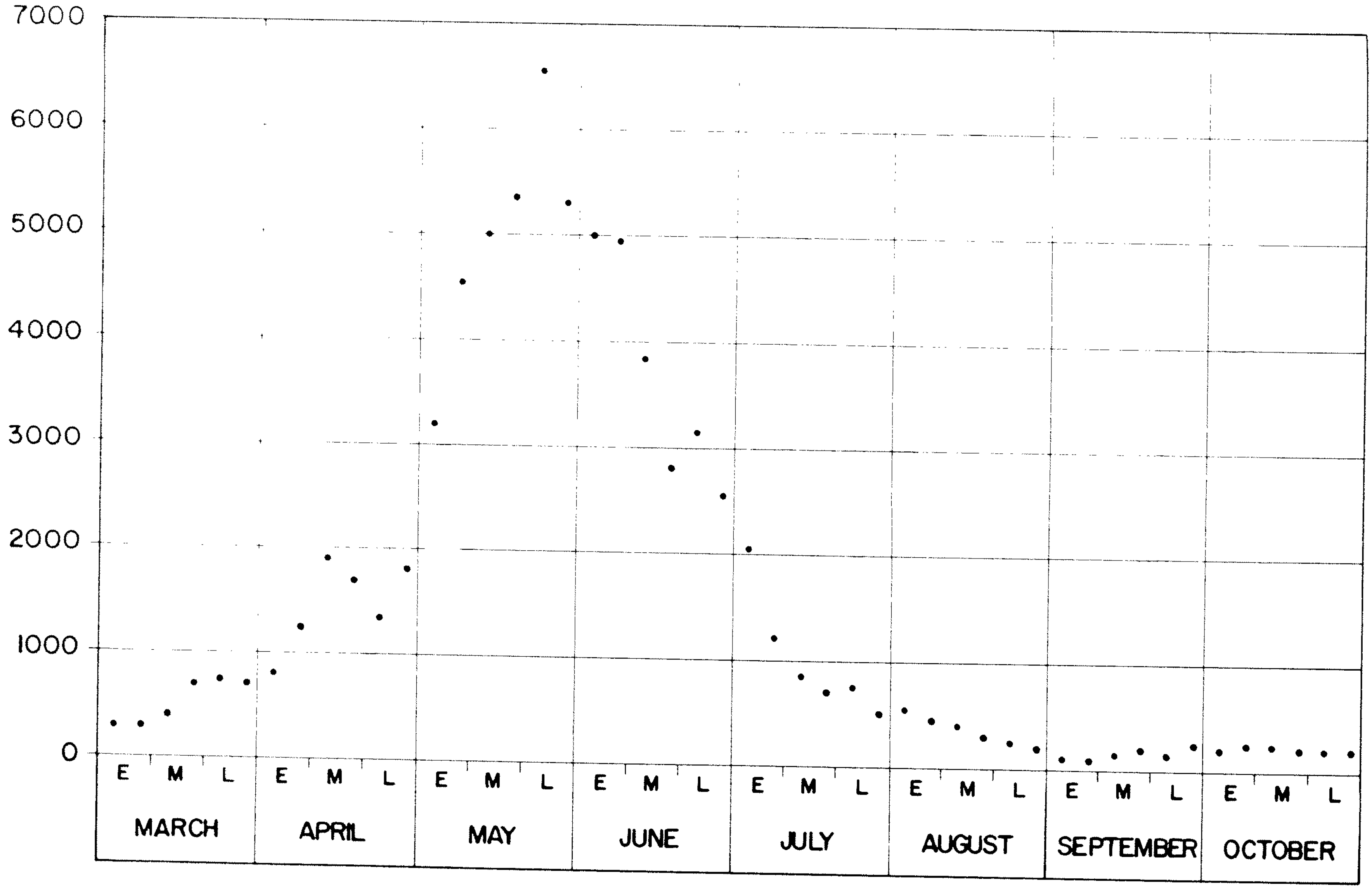



Figure 10. USGS flow data averaged over 5-day intervals to the nearest 50 cfs for Yampa River at Maybell, 1976.

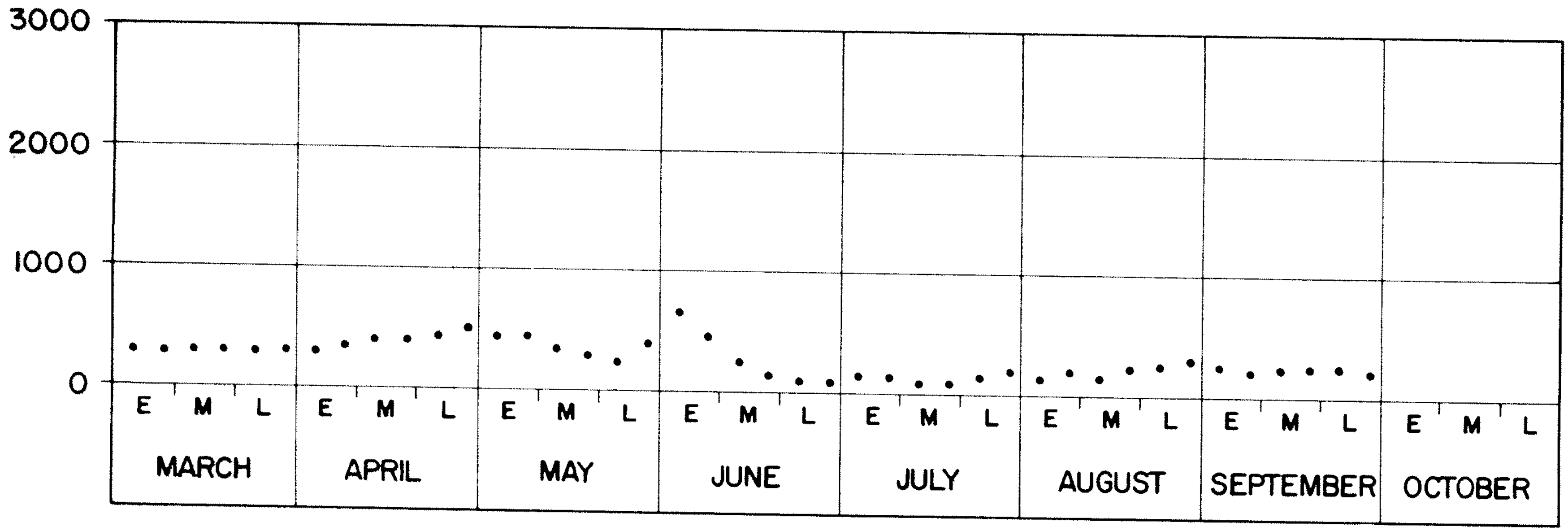



Figure 11. USGS flow data averaged over 5-day intervals to the nearest 50 cfs for White River below Meeker, 1977.

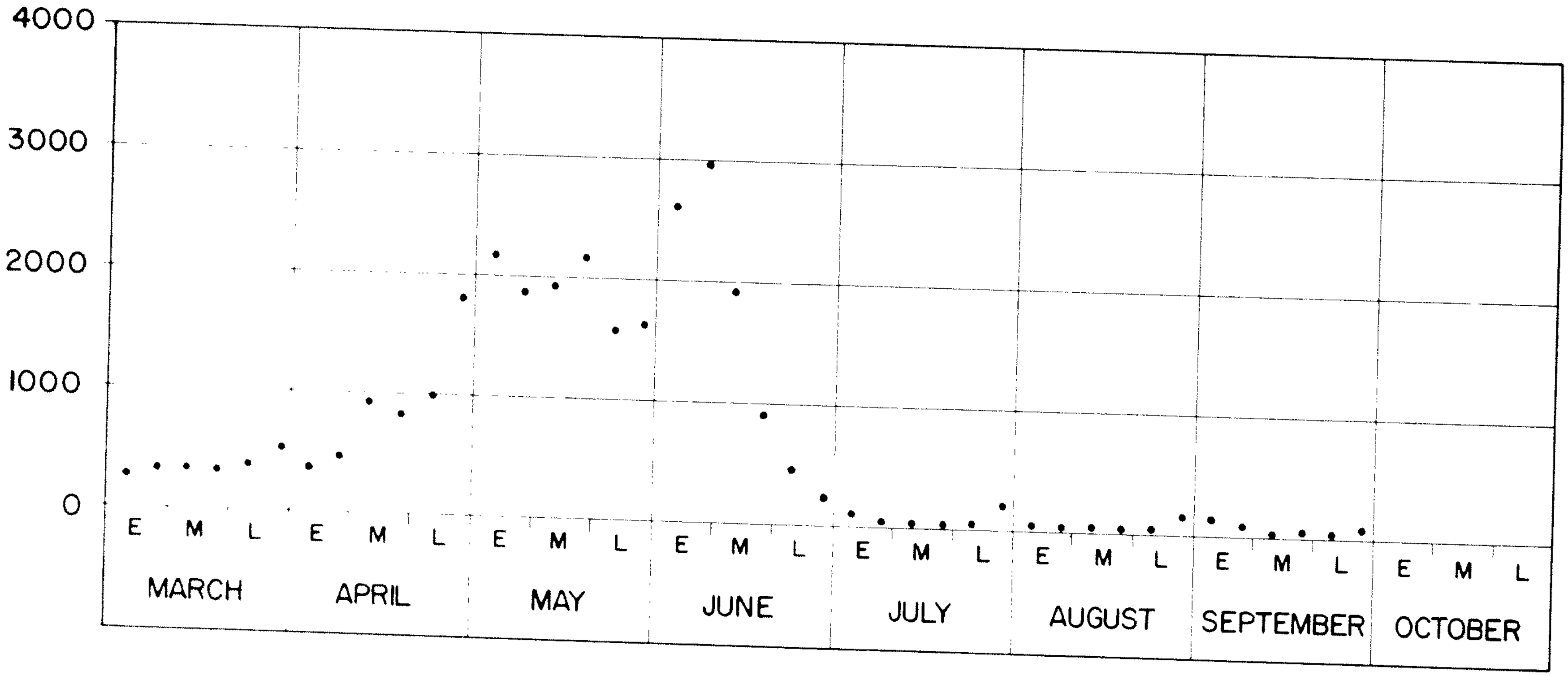



Figure 12. USGS flow data averaged over 5-day intervals to the nearest 50 cfs for Yampa River near Maybell, 1977.

Food habits

Stomachs of 14 mountain whitefish (218-310 mm TL) collected from Yampa River Stations Y-1 and Y-2 in September 1975 contained 12 groups of organisms identified to order or family (Table 28). No empty stomachs occurred in the sample. Chironomid larvae comprised the greatest numeric and volumetric invertebrate components of the ration. Simuliid and chironomid pupae were numerous in the stomachs, and most of the former were in a very advanced stage. The sample contained whitefish which varied in total length from 218 to 310 mm. Larger fish had eaten proportionately more chironomid larvae than had smaller fish, but strong selective preferences were not apparent within size classes in the sample. Electivity values showed strong selection for simuliid pupae (Table 29). Selection for chironomidae was not analyzed. All other organisms were avoided (as defined by negative E values). Ephemerellid mayflies and hydropsychid caddisflies were only moderately avoided, and their abundance in the invertebrate collections indicated that availability may limit their use as food.

Channel catfish food-habits analysis was based on stomach samples taken at Station Y-4 on September 20, 1975. Stomachs of seventeen channel catfish ranging from 160 to 640 mm TL were analyzed, and all contained only filamentous green algae and epiphytic diatoms. As catfish were not numerous enough to allow food habits analysis earlier in the summer, no seasonal changes in food habits could be noted.

Table 28. Food of mountain whitefish collected at Yampa River Stations Y-1 and Y-2, September 1975. (Digestive tracts from 14 fish ranging 218-310 mm T.L.)

| Food item | Frequency of occurrence (%) | Number | | Volume | |
|---|---|---|---|---|---|
| | | Total | % | Total | % |
| Chironomidae larvae | 100 | 815 | 62.45 | 1.71 | 16.13 |
| Chironomidae pupae | 64.2 | 146 | 11.18 | .576 | 5.43 |
| Simuliidae larvae | 14.2 | 6 | .46 | -- | -- |
| Simuliidae pupae | 71.4 | 207 | 15.86 | 1.035 | 9.76 |
| Ephemerellidae | 50 | 79 | 6.05 | .024 | .23 |
| Baetidae | 42.8 | 12 | .92 | .04 | .38 |
| Heptageniidae | 35.7 | 7 | .54 | .02 | .19 |
| Plecoptera | 42.8 | 6 | .46 | .06 | .57 |
| Hydropsychidae | 35.7 | 16 | 1.23 | .06 | .57 |
| Stone cases | 14.2 | 9 | .69 | .47 | 4.43 |
| Rhagionidae | 7.1 | 1 | .077 | .004 | .03 |
| Ceratopogonidae | 7.1 | 1 | .077 | .004 | .03 |
| Detritus | 100 | -- | -- | 6.60 | 62.25 |

Table 29. Feeding electivity (E) of mountain whitefish collected at Yampa River Stations Y-1 and Y-2, September 1975.

| Food item | Items in environment* No. | % | Percent of item in ration | E |
|---|---|---|---|---|
| Chironomidae larvae | -- | -- | 62.45 | -- |
| Chironomidae pupae | -- | -- | 11.18 | -- |
| Simuliidae larvae | 224 | 5.6 | .46 | - .848 |
| Simuliidae pupae | 0 | 0 | 15.86 | +1 |
| Ephemerellidae | 872 | 22.17 | 6.05 | - .57 |
| Baetidae | 609 | 15.48 | 92 | - .89 |
| Heptageniidae | 1596 | 40.58 | 54 | - .97 |
| Plecoptera | 68 | 1.72 | .46 | - .57 |
| Hydropsychidae | 252 | 6.40 | 1.23 | - .67 |
| Rhagionidae | 312 | 7.93 | .077 | - .98 |
| Ceratopogonidae | 0 | 0 | .077 | +1 |

*Data from Ames preliminary report.

Gut content analysis of bluehead and flannelmouth suckers collected in August and September 1975 showed that they consumed mostly periphyton and concommitant diatoms and macroinvertebrates. An analysis of the algal component of the rations of selected fish suggested that diatoms and green algae were most ingested (Table 30). Fragmentation and decomposition of invertebrates made meaningful identification impossible.

Food habits of redside shiners were analyzed because of suggestions that they might compete for food with or prey on young squawfish. Stomach contents of redside shiners collected from Stations Y-3 and Y-4 from June through October 1976 were studied. Because of the advanced state of decomposition of most food items, identifications were not always certain. The objective of the analysis was to demonstrate relative uses of major food groups such as small fish, insects, invertebrate eggs, algae or detritus. The inclusion of an insect order in tabulated data indicates that the remains were definitely those of an insect, most probably of the order specified. True fly adults occurred more frequently than any other food item in the redside shiner stomachs collected on all five collection dates (Table 31). This frequency did not occur in other samples, but a consistently-high frequency of immature dipterans occurred in all samples except that from Station Y-4 on July 16. Immature caddisflies and adult mayflies were encountered least frequently. No identifiable food item occurred at all stations on all dates. The Y-4 sample taken on June 23 contained an exceptionally-high proportion of unidentifiable material because of the advanced state of decomposition of the contents. The Y-4 sample from October 10 contained a large proportion of empty stomachs.

Table 30. Analysis of algal component of bluehead and flannelmouth sucker stomach contents, Yampa and White Rivers, 1975. (- absent, + present, ++ comprising between 30 and 50% of the total algal mass.)

| Alga | Fish* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Division Bacillariophyta | | | | | | | | | |
| *Achnanthes lanceolata* | + | - | + | - | - | + | + | + | + |
| *Achnanthes minutissima* | + | - | - | - | - | - | - | - | - |
| *Caloneis amphisbaena* | - | - | - | + | - | + | - | - | - |
| *Cocconeis placentula* | + | - | + | + | - | + | - | + | ++ |
| *Cyclotella meneghiniana* | - | - | + | - | - | - | - | - | - |
| *Cymatopleura solea* | + | - | - | - | - | - | - | - | - |
| *Cymbella affinis* | + | - | - | - | - | - | + | - | - |
| *Cymbella* sp. (possibly *mexicanum*) | + | - | - | + | - | - | - | - | - |
| *Cymbella turgida* | + | - | - | - | - | - | - | - | - |
| *Cymbella ventricosa* | - | - | - | - | - | - | + | - | - |
| *Diatoma anceps* | ++ | - | - | - | - | + | + | - | - |
| *Diatoma elongatum* | - | - | - | - | - | - | - | - | - |
| *Diatoma vulgare* | + | + | + | +++ | +++ | +++ | + | +++ | + |
| *Epithemia sorex* | ++ | - | + | + | + | + | + | - | + |
| *Epithemia turgida* | - | - | + | + | - | + | - | - | - |
| *Fragilaria capucina* | - | - | - | - | - | - | - | - | - |
| *Fragilaria construens* | + | - | - | - | - | - | + | - | - |
| *Gomphonema constrictum* | + | - | + | + | - | - | + | - | - |
| *Gomphonema olivaceum* | + | - | + | + | - | + | + | + | + |
| *Gomphonema parvulum* | + | - | + | - | - | - | + | - | + |
| *Hannea arcus* | + | - | - | - | - | - | - | - | - |
| *Melosira ambigua* (?) | - | - | + | - | - | - | - | - | - |
| *Melosira varians* | - | - | + | ++ | + | - | - | - | + |
| *Navicula* sp. 1 | + | - | + | - | - | - | - | + | + |
| *Navicula* sp. 2 | + | - | - | + | - | - | - | + | + |
| *Navicula canalis* | - | - | - | + | - | - | - | - | - |
| *Navicula cryptocephala* | + | - | - | - | - | - | + | + | + |
| *Navicula exigua* | - | - | + | - | - | - | - | - | - |
| *Navicula viridula* | + | - | - | - | - | - | + | - | - |
| *Nitzschia acicularis* | - | - | + | + | + | - | - | - | + |
| *Nitzschia apiculata* | - | - | - | - | - | - | + | - | - |
| *Nitzschia hungarica* | + | - | - | - | - | - | - | - | + |
| *Nitzschia palea* | + | - | + | + | - | - | - | + | + |
| *Nitzschia sigmoidea* | + | - | + | + | - | - | + | - | - |
| *Pinnularia* sp. | + | - | - | - | - | - | + | - | - |
| *Rhoicospenia curvata* | + | - | - | - | - | - | - | - | + |
| *Rhopalodia gibba* | + | - | - | + | - | - | + | - | + |
| *Stephanodiscus hantzschii* | + | - | - | - | - | - | - | - | - |
| *Surirella ovata* | + | - | - | - | - | - | - | - | - |
| *Synedra tabulata* | + | - | - | - | - | - | - | - | - |
| *Synedra ulna* | ++ | - | + | - | - | - | +++ | + | + |
| *Tabellaria* sp. | - | - | - | + | - | - | - | - | - |

Table 30. Continued.

| Alga | Fish* 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Division Chlorophyta | | | | | | | | | |
| Ankistrodesmus falcatus | - | - | + | - | - | - | - | - | - |
| Cladophora glomerata | - | - | ++ | ++ | - | - | - | - | - |
| Cosmarium sp. 1 | + | - | + | + | - | - | - | + | + |
| Cosmarium sp. 2 | - | - | + | + | - | - | - | - | - |
| Cosmarium sp. 3 | - | - | + | - | - | - | - | - | - |
| Scenedesmus acuminatus | - | - | + | + | - | - | - | - | + |
| Spirogyra sp. | - | - | + | - | - | - | - | - | - |
| Staurastrum orbiculare | - | - | + | + | - | - | - | - | - |
| Staurastrum rogosum | - | - | + | - | - | - | - | - | - |
| Stigeoclonium tenue | - | - | + | - | - | - | - | - | - |
| Rhizoclonium hierglyphicum | - | - | ++ | ++ | - | - | - | - | - |
| Ulothrix sp. | - | - | + | - | - | - | - | - | - |
| Zygnema sp. | - | - | + | - | - | - | - | - | - |
| Division Cyanophyta | | | | | | | | | |
| Anabaena sp. | - | - | - | + | - | - | - | - | - |
| Dactylococcopsis raphidioides | - | - | + | - | - | - | - | - | - |
| Oscillatoria sp. | + | - | - | - | - | - | + | - | + |
| Phormidium sp. | + | - | - | - | - | - | - | - | - |
| Division Rhodophyta | | | | | | | | | |
| Lemanea sp. (carpospores) | - | - | - | - | - | - | - | - | - |

*

| Fish # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Species | FMS | BHS | BHS | BHS | BHS | FMS | FMS | FMS x WS | FMS |
| Date | 8/25 | 7/12 | 9/19 | 9/19 | 8/25 | 9/19 | 8/25 | 8/25 | 8/25 |
| Station | Y-3 | W-B | Y-4 | Y-1 | X-mtn | Y-3 | Y-3 | Y-3 | Y-3 |
| Total Length(mm) | 340 | 350 | 280 | 327 | 265 | 480 | 340 | 420 | 420 |
| Weight(g) | 360 | 455 | 260 | - | 280 | 1135 | 360 | 860 | 720 |

Table 31. Frequency of occurrence of food items from redside shiner stomachs collected June - October 1976 from the Yampa River.

| Station | Y-3 | | | Y-4 | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | 6/22 | 7/16 | 8/5 | 6/23 | 7/16 | 8/5 | 8/19 | 10/10 |
| Number of stomachs | 16 | 21 | 8 | 22 | 11 | 22 | 24 | 30 |
| Diptera | | | | | | | | |
| Adults | 25 | 76 | 12.5 | 0 | 9.1 | 9.1 | 33.3 | 3.3 |
| Immature | 6.3 | 4.76 | 0 | 0 | 27.3 | 22.7 | 12.5 | 3.3 |
| Ephemeroptera | | | | | | | | |
| Adults | 1.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Immature | 0 | 9.5 | 0 | 4.5 | 9.1 | 0 | 4.2 | 0 |
| Hemiptera | | | | | | | | |
| Adults | 0 | 0 | 0 | 9.1 | 0 | 0 | 0 | 3.3 |
| Trichoptera | | | | | | | | |
| Immature | 0 | 0 | 0 | 0 | 27.3 | 0 | 0 | 0 |
| Hymenoptera | | | | | | | | |
| Adults | 3.1 | 4.7 | 0 | 0 | 0 | 0 | 4.2 | 3.3 |
| Empty stomachs | 0 | 0 | 37.5 | 22.7 | 27.3 | 13.6 | 12.5 | 70.0 |
| Invertebrate eggs | 0 | 19 | 50 | 0 | 0 | 9.1 | 0 | 0 |
| Unidentifiable[a] | 0 | 0 | 12.5 | 0 | 0 | 4.5 | 29.2 | 13.3 |
| Unidentified invertebrates[b] | 0 | 0 | 0 | 63.6 | 0 | 0 | 0 | 10.0 |
| Coleoptera larvae | 0 | 0 | 0 | 54 | 54.5 | 0 | 0 | 0 |

[a]Denotes percentage of stomachs which contained no identifiable food organisms.

[b]Denotes percentage of stomachs which contained some unidentifiable organisms.

# MACROINVERTEBRATES

## *Methods*

### Collection

Most macroinvertebrate-collection sites were sampled twice a month from July through October 1975, once in November 1975, and monthly from March 1976 until October 1976 (Tables 7 and 8). Sampling in June 1976 was ommitted due to high water.

Samples were collected with a D-shaped kick net about 32 cm wide, 27 cm high at the middle and 42 cm deep. The mesh size was 1.0 x 0.7 mm. A kick net provides for some numerical assessment of the differences between areas (Hynes 1970) and can be used on a wide variety of substrates (Morgan and Egglishaw 1965).

The net was held vertically against the stream bed as the substrate immediately above the net was vigorously stirred by kicking. Each sample consisted of 1 min of kicking during which the net was moved two or three times to different portions of the same habitat. Riffle samples were taken at all sites to allow for comparisons between the sites. Other samples were usually from a deeper pool area, a slower near-shore area, and/or a deeper, slower mainstream area, depending on accessibility and uniformity of the stream section. An attempt was made to sample in as many habitats as possible to obtain a comprehensive overview of the invertebrate communities at each sampling site.

Collections were preserved in 70% ethanol and returned to the laboratory for sorting and identification. Some samples, usually those taken during October or November when populations were highest, were sub-sampled because of the large numbers of organisms.

## Data Analysis

Organisms were identified primarily by use of keys provided by Pennak (1953), Usinger (1956), Edmondson (1959) and Mason (1973). The works of Burks (1953), Allen and Edmonds (1959, 1962, 1965), Berner (1959) and Jensen (1966) were used for species identification.

Shannon-Weaver diversity indices (Wilhm and Dorris, 1968) were calculated from the machine formula presented by Weber (1973). Many taxa which were not identified to species were treated as such for purposes of diversity index calculation

A two-way analysis of variance of total numbers collected at each site was used to determine seasonal or longitudinal trends on the Yampa and White Rivers.

# *Results*

## Aquatic insects:species composition

A total of 100 insect taxa was collected from the Yampa River (Tables 32 and 33). Mayflies were the most abundant order at most sites. *Ephemerella inermis*, *Baetis* sp., *Tricorythodes minutus*, and *Rhithrogena* sp. were common at all sites. Caddisflies were the next most abundant order, with *Hydropsyche* sp. and *Cheumatopsyche* sp. common at all sites. Stoneflies, true flies and beetles were the other important orders, and Chironomidae (Diptera) was the most common family. Several less-abundant taxa were found at all sites (Table 33). Seventy-seven insect taxa were collected from four sampling sites on the White River (Tables 34 and 35). *Ephemerella inermis* was generally the predominant group. *Hydropsyche* sp. and Chironomidae were the next most common taxa. Total numbers of all taxa collected are presented in Appendix VI.

Table 32. Mean number of individuals of the most common insect taxa collected from riffles of the Yampa River, Colorado, July 1975 to October 1976.

| Taxon | Sampling Sites Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Total |
|---|---|---|---|---|---|---|---|
| EPHEMEROPTERA | | | | | | | |
| Ephemerellidae | | | | | | | |
| *Ephemerella inermis* Eaton | 28 | 304 | 1103 | 455 | 61 | 55 | 2006 |
| Baetidae | | | | | | | |
| *Baetis* sp. A | 48 | 54 | 66 | 30 | 30 | 23 | 251 |
| *Baetis* sp. B | 96 | 42 | 151 | 52 | 69 | 67 | 477 |
| Heptageniidae | | | | | | | |
| *Rhithrogena* sp. | 165 | 151 | 382 | 77 | 91 | 39 | 905 |
| *Heptagenia* sp. | 2 | 0 | 0 | 0 | 1 | 16 | 19 |
| Tricorythidae | | | | | | | |
| *Tricorythodes minutus* Traver | 6 | 7 | 118 | 335 | 42 | 96 | 604 |
| Leptophlebiidae | | | | | | | |
| *Paraleptophlebia* sp. A | 1 | 10 | 5 | 5 | 1 | 1 | 23 |
| *Traverella albertana* (McDunnough) | 0 | 0 | 0 | 3 | 6 | 4 | 13 |
| *Choroterpes albiannulata* (McDunnough) | 1 | 4 | 9 | 33 | 1 | 1 | 49 |
| Polymitarcidae | | | | | | | |
| *Ephoron album* (Say) | 1 | 0 | 1 | 11 | 8 | 6 | 27 |
| TRICHOPTERA | | | | | | | |
| Hydropsychidae | | | | | | | |
| *Hydropsyche* sp. | 10 | 75 | 118 | 92 | 63 | 46 | 404 |
| *Cheumatopsyche* sp. | 11 | 75 | 236 | 80 | 143 | 50 | 595 |
| Brachycentridae | | | | | | | |
| *Brachycentrus* sp. | 2 | 19 | 1 | 1 | 3 | 1 | 27 |
| Leptoceridae | | | | | | | |
| *Oecetis* sp. | 1 | 1 | 57 | 16 | 36 | 13 | 124 |
| Lepidostomatidae | | | | | | | |
| *Lepidostoma* sp. | 8 | 3 | 1 | 0 | 0 | [illegible] | 12 |
| Hydroptilidae | | | | | | | |
| *Hydroptila* sp. | 1 | 1 | 10 | 15 | 1 | 1 | [illegible] |
| Glossosomatidae | | | | | | | |
| *Protoptila* sp. | 0 | 0 | 7 | 16 | 20 | 26 | [illegible] |
| Helicopsychidae | | | | | | | |
| *Helicopsyche* sp. | 0 | 0 | 1 | 1 | 13 | [illegible] | 1 |

Table 32. Continued.

| Taxon | Sampling Sites | | | | | | |
|---|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Total |
| PLECOPTERA | | | | | | | |
| Perlodidae | | | | | | | |
| *Isoperla* sp. | 4 | 8 | 111 | 28 | 5 | 4 | 160 |
| *Isogenus* sp. | 4 | 6 | 5 | 5 | 20 | 9 | 49 |
| Perlidae | | | | | | | |
| *Claassenia sabulosa* (Banks) | 1 | 5 | 38 | 10 | 3 | 4 | 61 |
| Chloroperlidae | | | | | | | |
| *Alloperla* sp. | 30 | 33 | 26 | 1 | 1 | 0 | 87 |
| Pteronarcidae | | | | | | | |
| *Pteronarcys californica* Newport | 1 | 1 | 1 | 0 | 0 | 0 | 3 |
| *Pteronarcella badia* (Hagen) | 26 | 33 | 26 | 1 | 1 | 0 | 87 |
| Nemouridae | | | | | | | |
| *Brachyptera* sp. | 0 | 1 | 19 | 3 | 7 | 3 | 33 |
| *Capnia* sp. | 0 | 0 | 0 | 42 | 3 | 1 | 46 |
| DIPTERA | | | | | | | |
| Rhagionidae | | | | | | | |
| *Atherix variegata* Walker | 98 | 16 | 88 | 26 | 2 | 2 | 232 |
| Simuliidae (larvae) | 47 | 12 | 76 | 4 | 1 | 1 | 141 |
| Tipulidae | | | | | | | |
| *Hexatoma* sp. | 26 | 14 | 22 | 5 | 3 | 1 | 71 |
| Chironomidae | 31 | 63 | 161 | 263 | 41 | 79 | 638 |
| LEPIDOPTERA | | | | | | | |
| Pyralidae | | | | | | | |
| *Cataclysta* sp. | 0 | 0 | 1 | 1 | 4 | 13 | 19 |
| COLEOPTERA | | | | | | | |
| Elmidae | | | | | | | |
| *Microcylleopis* sp. | 1 | 1 | 2 | 4 | 2 | 10 | 20 |
| *Zaitzevia* sp. | 19 | 25 | 37 | 14 | 2 | 1 | 98 |
| *Dubiraphia* sp. | 0 | 1 | 1 | 5 | 1 | 1 | 9 |
| *Optioservus* sp. | 44 | 21 | 25 | 7 | 1 | 0 | 98 |

Table 33. Distribution of less-abundant insect taxa from the Yampa River, Colorado, July 1975 to October 1976.

| Taxon | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 |
|---|---|---|---|---|---|---|
| EPHEMEROPTERA | | | | | | |
| Ephemeridae | | | | | | |
| *Ephemera simulans* Walker | | | X | X | X | X |
| Ephemerellidae | | | | | | |
| *Ephemerella hecuba* | X | X | | | | |
| *E. grandis* | X | X | X | X | | |
| Baetidae | | | | | | |
| *Pseudocloeon* sp. | | | X | | | |
| Heptageniidae | | | | | | |
| *Epeorus* sp. | X | X | X | | | |
| Leptophlebiidae | | | | | | |
| *Paraleptophlebia* sp. B | | X | | | | |
| *Leptophlebia* sp. | | | | X | | |
| Siphlonuridae | | | | | | |
| *Ameletus* sp. | X | X | X | X | X | X |
| Ametropidae | | | | | | |
| *Ametropus albrighti* Travers | | | | | X | |
| Caenidae | | | | | | |
| *Caenis* sp. | X | X | X | X | | |
| *Brachycercus* sp. | | | X | | | |
| Oligonuridae | | | | | | |
| *Lachlania saskatchewanensis* Ide | | | | | | X |
| TRICHOPTERA | | | | | | |
| Hydropsychidae | | | | | | |
| *Arctopsyche* sp. | X | X | X | X | | |
| *Parapsyche* sp. | X | | | | | |
| Leptoceridae | | | | | | |
| *Trianenodes* sp. | | | X | X | X | X |
| Hydroptilidae | | | | | | |
| *Orthotrichia* sp. | | | | | X | |
| *Agraylea* sp. | | | | X | | |
| *Mayatrichia* sp. | | | | | X | X |
| *Leucotrichia* sp. | X | X | X | X | X | X |
| *Neotrichia* sp. | X | | | | | |

Sampling Sites: Y1–Y6.

Table 33. Continued.

| Taxon | Sampling Sites | | | | | |
|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 |
| Limnephilidae | | | | | | |
| *Drusinus* sp. | X | | | | | |
| *Platycentropus* sp. | | X | | | | |
| *Hesperophylax* sp. | | | | X | | |
| Glossosomatidae | | | | | | |
| *Glossosoma* sp. | X | | | | | |
| Psychomyidae | | | | | | |
| *Psychomyia* sp. | X | X | X | X | X | X |
| *Neureclipsis* sp. | | | X | | X | |
| *Polycentropus* sp. | | | | | X | X |
| DIPTERA | | | | | | |
| Simuliidae (pupae) | | | | | | |
| *Simulium venustum* Say | X | | X | | | |
| *S. virgatum* Coquillet | | | X | | | |
| *S. bivittatum* Malloch | X | X | X | X | | |
| *S. argus* Williston | X | | | | | |
| *S. arcticum* Malloch | | X | X | X | | |
| *S. vittatum* Zetterstedt | | | X | | | |
| Tipulidae | | | | | | |
| *Tipula* sp. | | X | | | | |
| *Ormosia* sp. | | | X | | | |
| Empididae | X | X | X | X | X | X |
| Ceratopogonidae | | | | | | |
| *Palpomyia* sp. | X | X | X | X | X | X |
| Deuterophlebiidae | X | | | | | |
| Tanyderidae | | | | | | |
| *Protanyderus* sp. | | X | | | | |
| Ephydridae | X | | | | | |
| Stratiomyidae | | | | | | |
| *Stratiomys* sp. | X | | | | | |
| Blepharoceridae | X | | | | | |
| Psychodidae | | | | | | |
| *Pericoma* sp. | X | | | | | |
| Dolichopodidae | | | X | | | |

Table 33. Continued.

| Taxon | Sampling Sites | | | | | |
|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y4 | Y5 | Y |
| PLECOPTERA | | | | | | |
| Perlidae | | | | | | |
| *Acroneuria* sp. | | | X | | | |
| Nemouridae | | | | | | |
| *Nemoura* sp. | X | | | | | |
| Perlodidae | | | | | | |
| *Arcynopteryx* sp. | | X | X | X | | |
| COLEOPTERA | | | | | | |
| Haliplidae | | | | | | |
| *Haliplus* sp. | | X | | | | |
| *Brychius* sp. | | X | | | | |
| Dytiscidae | | | | | | |
| *Laccodytes* sp. | | | | | X | |
| *Eretes* sp. | | | | X | | |
| *Derovatellus* sp. | X | | | | | |
| *Hydrovatus* sp. | | | X | | | |
| Hydraenidae | | | | | | |
| *Ochthebius* sp. | | X | | | | |
| Dryopidae | | | | | | |
| *Dryops* sp. | | | | X | | |
| Hydrophilidae | | | | | | |
| *Heophorus* sp. | X | | | | | |
| HEMIPTERA | | | | | | |
| Corixidae | X | X | X | X | X | X |
| Veliidae | | | | | | |
| *Rhagovelia* sp. | | X | X | X | X | |
| Naucoridae | | | | | | |
| *Ambrysus mormon* Montandon | | | | X | X | X |
| ODONATA | | | | | | |
| Gomphidae | | | | | | |
| *Ophiogomphus* sp. | | | X | X | X | X |

Table 34. Mean number of individuals of the most common insect taxa collected from riffles of the White River, July 1975 to September 1976.

| Taxon | Sampling Sites W1A | W1 | W2 | W3 | Total |
|---|---|---|---|---|---|
| EPHEMEROPTERA | | | | | |
| Ephemerellidae | | | | | |
| *Ephemerella inermis* | 455 | 255 | 473 | 56 | 1239 |
| Baetidae | | | | | |
| *Baetis* sp. A | 22 | 81 | 51 | 104 | 258 |
| *Baetis* sp. B | 261 | 101 | 113 | 27 | 502 |
| Heptageniidae | | | | | |
| *Heptagenia* sp. | 1 | 2 | 14 | 3 | 20 |
| *Rhithrogena* sp. | 18 | 25 | 29 | 24 | 96 |
| Tricorythidae | | | | | |
| *Tricorythodes minutus* | 1 | 120 | 230 | 52 | 403 |
| Leptophlebiidae | | | | | |
| *Paraleptophlebia* sp. A | 3 | 0 | 0 | 0 | 3 |
| *Traverella albertana* | 0 | 1 | 11 | 26 | 38 |
| *Choroterpes albiannulata* | 0 | 2 | 46 | 2 | 50 |
| Polymitarcidae | | | | | |
| *Ephoron album* | 0 | 1 | 0 | 0 | 1 |
| TRICHOPTERA | | | | | |
| Hydropsychidae | | | | | |
| *Hydropsyche* sp. | 102 | 124 | 232 | 11 | 469 |
| *Cheumatopsyche* sp. | 1 | 109 | 54 | 2 | 166 |
| Brachycentridae | | | | | |
| *Brachycentrus* sp. | 208 | 2 | 1 | 0 | 211 |
| Leptoceridae | | | | | |
| *Oecetis* sp. | 0 | 2 | 2 | 1 | 6 |
| Lepidostomatidae | | | | | |
| *Lepidostoma* sp. | 11 | 1 | 1 | 0 | 13 |
| Hydroptilidae | | | | | |
| *Hydroptila* sp. | 3 | 19 | 26 | 1 | 49 |
| Glossosomatidae | | | | | |
| *Protoptila* sp. | 1 | 0 | 0 | 2 | 3 |

Table 34. Continued.

| Taxon | W1A | W1 | W2 | W3 | Total |
| --- | --- | --- | --- | --- | --- |
| | Sampling Sites | | | | |
| PLECOPTERA | | | | | |
| Perlodidae | | | | | |
| *Isoperla* sp. | 21 | 40 | 75 | 1 | 137 |
| *Isogenus* sp. | 18 | 4 | 4 | 5 | 31 |
| Perlidae | | | | | |
| *Claassenia sabulosa* | 1 | 1 | 0 | 0 | 2 |
| Chloroperlidae | | | | | |
| *Alloperla* sp. | 7 | 2 | 0 | 1 | 10 |
| Pteronarcidae | | | | | |
| *Pteronarcella badia* | 59 | 1 | 0 | 0 | 60 |
| *Pteronarcys californica* | 3 | 0 | 0 | 0 | 3 |
| Nemouridae | | | | | |
| *Brachyptera* sp. | 0 | 0 | 0 | 4 | 4 |
| *Capnia* sp. | 0 | 0 | 0 | 4 | 4 |
| DIPTERA | | | | | |
| Rhagionidae | | | | | |
| *Atherix variegata* | 19 | 3 | 6 | 2 | 30 |
| Simuliidae (larvae) | 205 | 22 | 27 | 11 | 265 |
| Tipulidae | | | | | |
| *Hexatoma* sp. | 5 | 27 | 6 | 1 | 39 |
| Chironomidae | 81 | 116 | 48 | [illegible] | 257 |
| LEPIDOPTERA | | | | | |
| Pyralidae | | | | | |
| *Cataclysta* sp. | 0 | 0 | 19 | 1 | 20 |
| COLEOPTERA | | | | | |
| Elmidae | | | | | |
| *Microcylleopis* sp. | 0 | 5 | 13 | 1 | 19 |
| *Zaitzevia* sp. | 11 | 8 | 1 | 0 | 20 |
| *Dubiraphia* sp. | 0 | 0 | 1 | 1 | 2 |
| *Optioservus* sp. | 64 | 2 | 0 | 0 | 66 |

Table 35. Distribution of less-abundant insect taxa from the White River, Colorado, July 1975 to September 1976.

| Taxon | W1A | W1 | W2 | W3 |
|---|---|---|---|---|
| EPHEMEROPTERA | | | | |
| Ephemerellidae | | | | |
| *Ephemerella hecuba* | X | | | |
| *E. grandis* | X | | | |
| *E. doddsi* | X | | | |
| *E. margarita* | X | | | |
| Baetidae | | | | |
| *Pseudocloeon* sp. | | X | X | X |
| *Centroptilum* sp. | | X | | |
| Heptageniidae | | | | |
| *Epeorus* sp. | X | | | X |
| Ephemeridae | | | | |
| *Ephemera simulans* | | | | X |
| Leptophlebiidae | | | | |
| *Leptophlebia* sp. | X | | | |
| Siphlonuridae | | | | |
| *Ameletus* sp. | | | | X |
| Caenidae | | | | |
| *Caenis* sp. | | | X | X |
| *Brachycercus* sp. | | X | | |
| Oligonuridae | | | | |
| *Lachlania saskatchewanensis* | | | | X |
| TRICHOPTERA | | | | |
| Hydropsychidae | | | | |
| *Arctopsyche* sp. | X | | | |
| Leptoceridae | | | | |
| *Triaenodes* sp. | | | | X |
| Hydroptilidae | | | | |
| *Agraylea* sp. | | | | X |
| *Mayatrichia* sp. | | X | X | X |
| *Leucotrichia* sp. | | | | X |
| Limnephilidae | | | | |
| *Hesperophylax* sp. | X | | | |

(Sampling Sites: W1A, W1, W2, W3)

Table 35. Continued.

| Taxon | Sampling Sites W1A | W1 | W2 | W3 |
|---|---|---|---|---|
| Glossosomatidae | | | | |
| *Glossosoma* sp. | X | | | |
| Psychomyidae | | | | |
| *Psychomyia* sp. | X | X | | |
| DIPTERA | | | | |
| Simuliidae (pupae) | | | | |
| *Simulium bivittatum* | X | X | X | X |
| *S. argus* | X | | | |
| *S. venustum* | X | | | |
| *S. arcticum* | X | X | | |
| Tipuludae | | | | |
| *Tipula* sp. | | | | X |
| *Holorusia* sp. | | X | | |
| Ephydridae | | X | | |
| Stratiomyidae | | | | |
| *Stratiomys* sp. | X | | | |
| Blepharoceridae | X | | | |
| PLECOPTERA | | | | |
| Nemouridae | | | | |
| *Nemoura* sp. | X | | | |
| COLEOPTERA | | | | |
| Haliplidae | | | | |
| *Haliplus* sp. | X | | | |
| *Brychius* sp. | X | | | |
| HEMIPTERA | | | | |
| Corixidae | X | X | X | X |
| Veliidae | | | | |
| *Rhagovelia* sp. | | | X | X |
| Naucoridae | | | | |
| *Ambrysus mormon* | | | | X |
| ODONATA | | | | |
| Gomphidae | | | | |
| *Ophiogomphus* sp. | | X | X | X |

Aquatic insects:inventory by site

Total mean insect abundance increased from Site Y1 to Y3 on the Yampa River and then decreased to Site Y6 (Figure 13). Greater percentages of stoneflies and beetles (Elmidae) occurred at Site Y1 than at any other site (Figure 14). From Y3 to Y4, there was a general decrease in all major groups, probably because of changes in substrate and current velocity. Further decreases in all major groups were noted at Site Y5, and stoneflies and caddisflies decreased still more at Y6. Stoneflies and beetles showed a general downstream reduction in numbers as well as in percent composition (Figure 14). All other orders followed the longitudinal trend noted in total abundance (Figure 13). Ames (1977) presented greater detail on these changes.

The sampling site on the Williams Fork, WF1, showed a varied insect community with low abundance. The Williams Fork was a smaller stream than either the Yampa or White Rivers at the same elevation. The site sampled was directly below a coal mine and was heavily silted. The most common insect species were the same as those in the Yampa River.

On the White River, total mean insect abundance decreased moderately from Site W1A to W1, increased from W1 to W2, and then fell off sharply at W3 (Figure 15). At W1A, the uppermost White River site (and a fairly swift, narrow part of the river with a rubble substrate), there were many *Ephemerella inermis*, *Baetis* sp., *Brachycentrus* sp., simuliid larvae, *Pteronarcella badia*, *Optioservus* sp., and *Zaitzevia* sp. (Table 34). The decrease in insects from W1A to W1 was primarily due to a decrease in these seven taxa. The increase from W1 to W2 was due to an increase in mayflies. All major groups dropped off sharply at Site W3 except for *Traverella albertana* and the two-tailed *Baetis*, which increased. Ames (1977) presented additional detail on these phenomena.

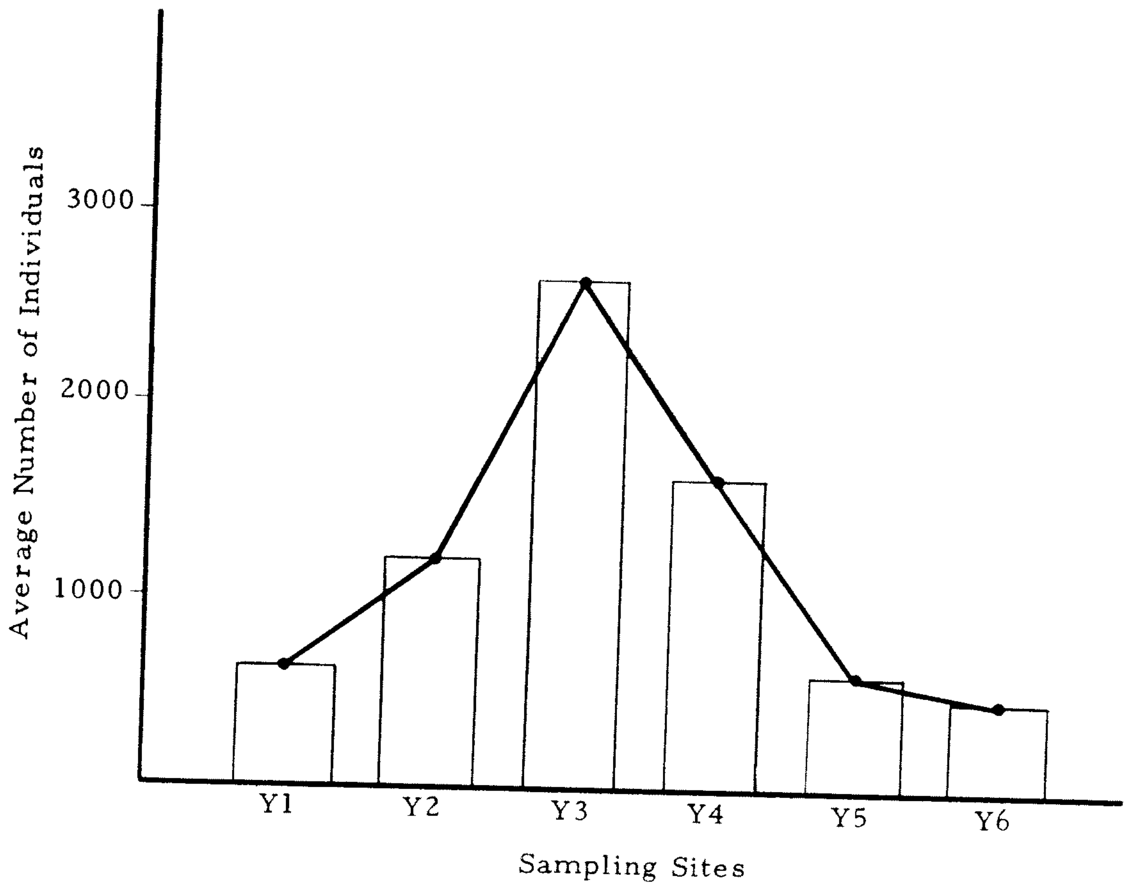



Figure 13. Average number of aquatic insects collected from the Yampa River from July 1975 to October 1976.

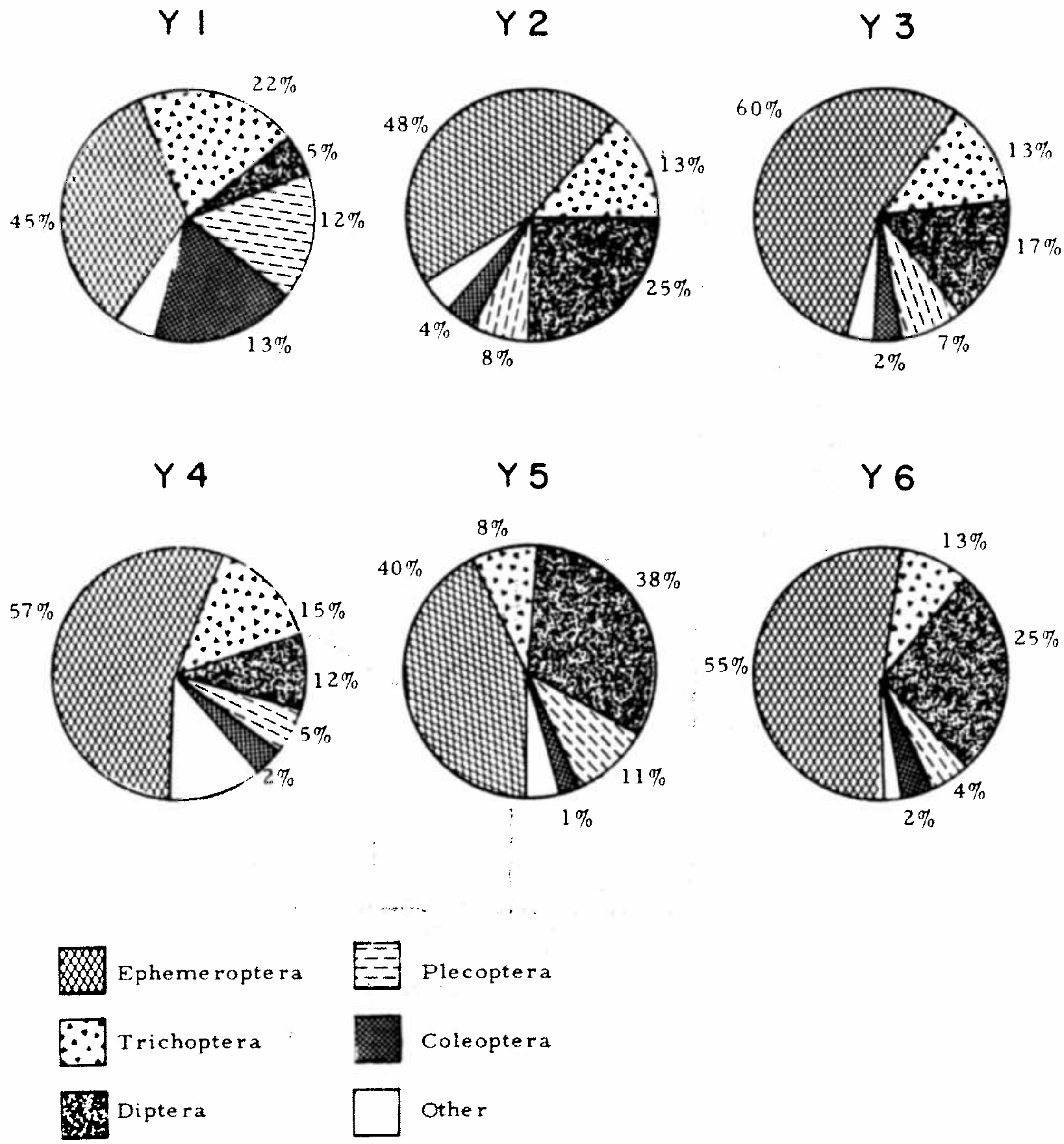



Figure 14. Change in percentage composition by numbers of the major insect orders at sampling sites on the Yampa River, Colorado, July 1975 to October 1976.

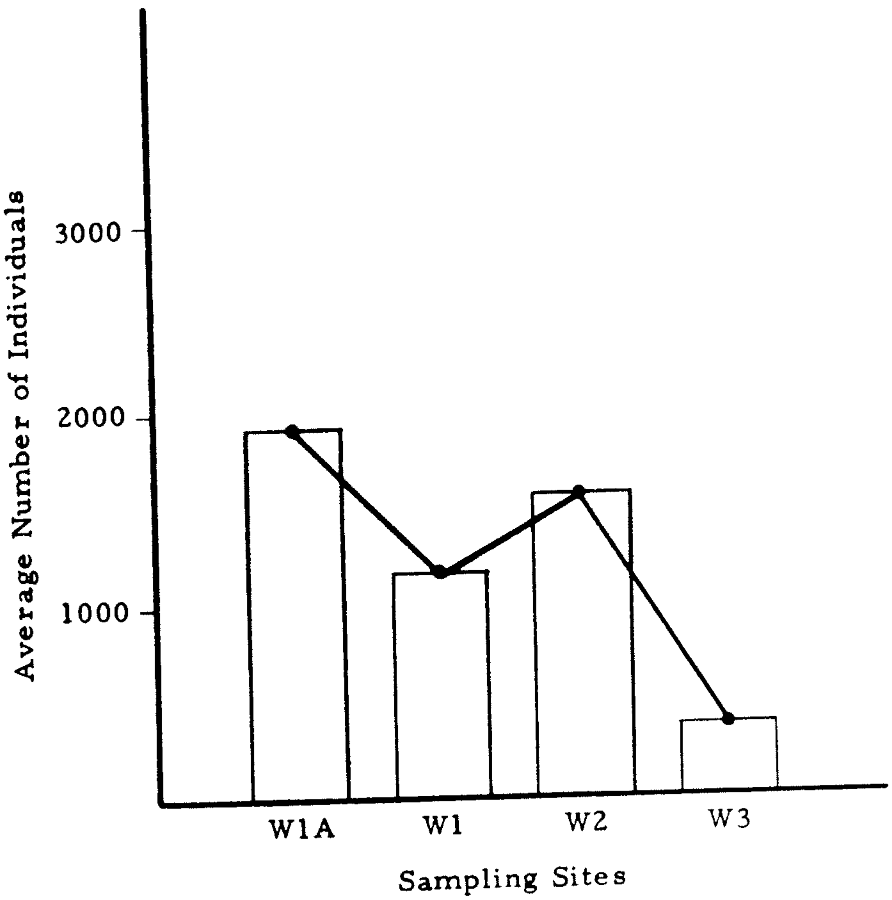



Figure 15. Average number of aquatic insects collected from the White River from July 1975 to September 1976.

Stoneflies and beetles decreased greatly from W1A to W1 in both percent composition and total abundance (Figure 16). Both groups remained minor parts of the fauna at Sites W2 and W3. Mayflies increased in importance from W1A to W3. This trend could also be seen on the Yampa River (Figure 14).

Aquatic insects:inventory by date

Running waters naturally show a seasonal fluctuation in aquatic insect abundance as well as in species composition. Generally, numbers of collected insects are low in the spring when many species have emerged, increase during the summer, and peak in the fall months (when many organisms are early instars which overwinter). A second, lower peak in the early spring is caused by delayed egg hatching and maturation of early instars over the winter. A drop in numbers corresponds with spring emergence (Hynes 1970). The aquatic insects of the Yampa River followed this seasonal pattern with respect to total abundance. The highest peaks were in October and November of 1975 with a lower peak in March 1976 and another in October 1976 (Figure 17). Mayflies, caddisflies, stoneflies and true flies followed this pattern (Figure 18). *Ephemerella inermis* and *Tricorythodes minutus* became extremely abundant in October and November 1975 and in October 1976, accounting for much of the fall peak in numbers (Table 36). The peak and drop in numbers in spring 1976 was also due to these species.

*Hydropsyche* sp. and *Cheumatopsyche* sp. (Trichoptera) followed this same seasonal pattern. *Oecetis* sp. was abundant in the fall of 1975 and 1976 and was low in numbers in the spring and early summer (Table 36).

Plecopterans showed a higher peak in March 1976 than in October 1975. This was primarily due to the winter stoneflies, *Brachyptera* sp. and *Capnia* sp.

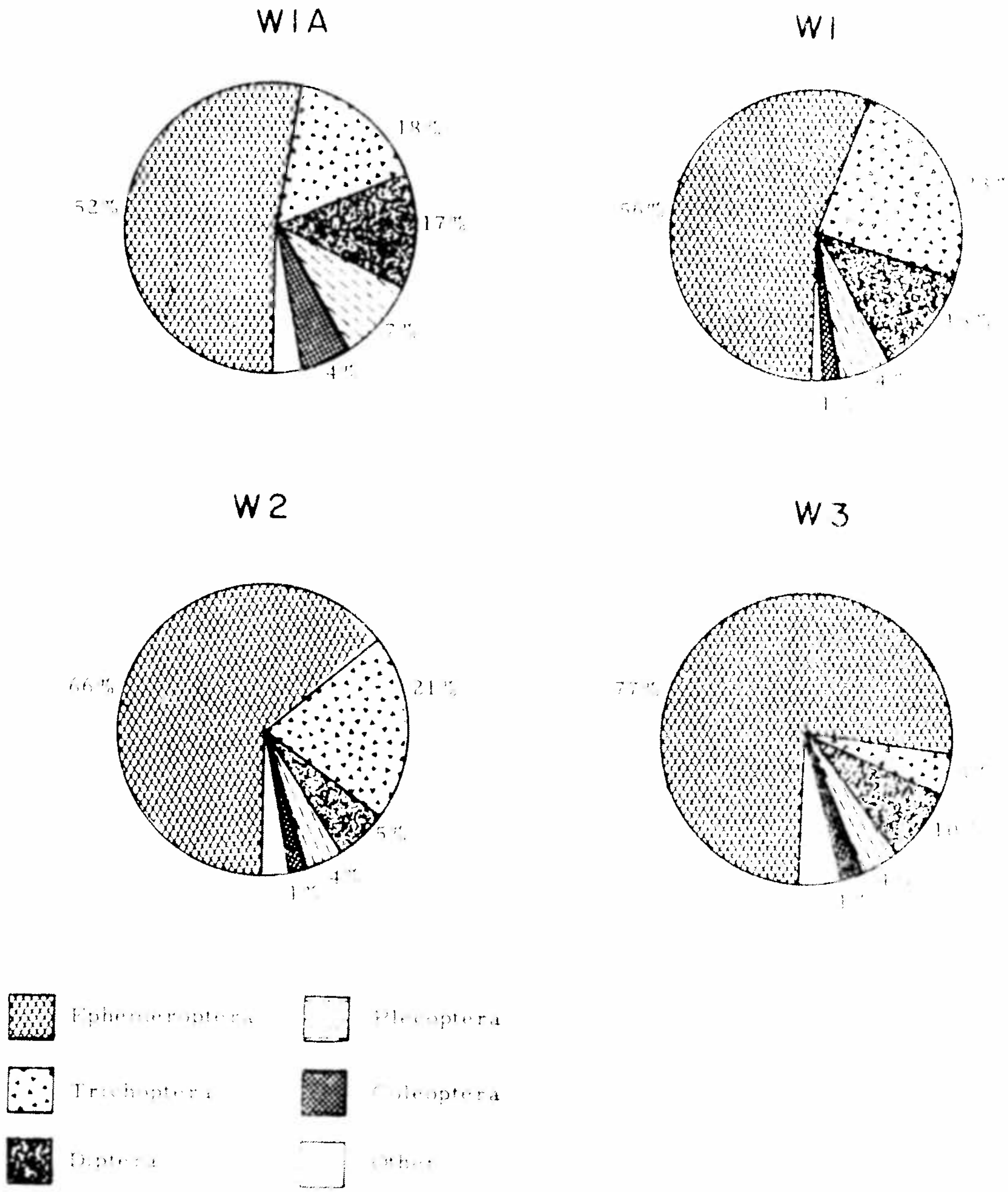



Figure 16. Change in percentage composition [illegible] the [illegible] the sampling [illegible] of the [illegible] River, [illegible] to [illegible].

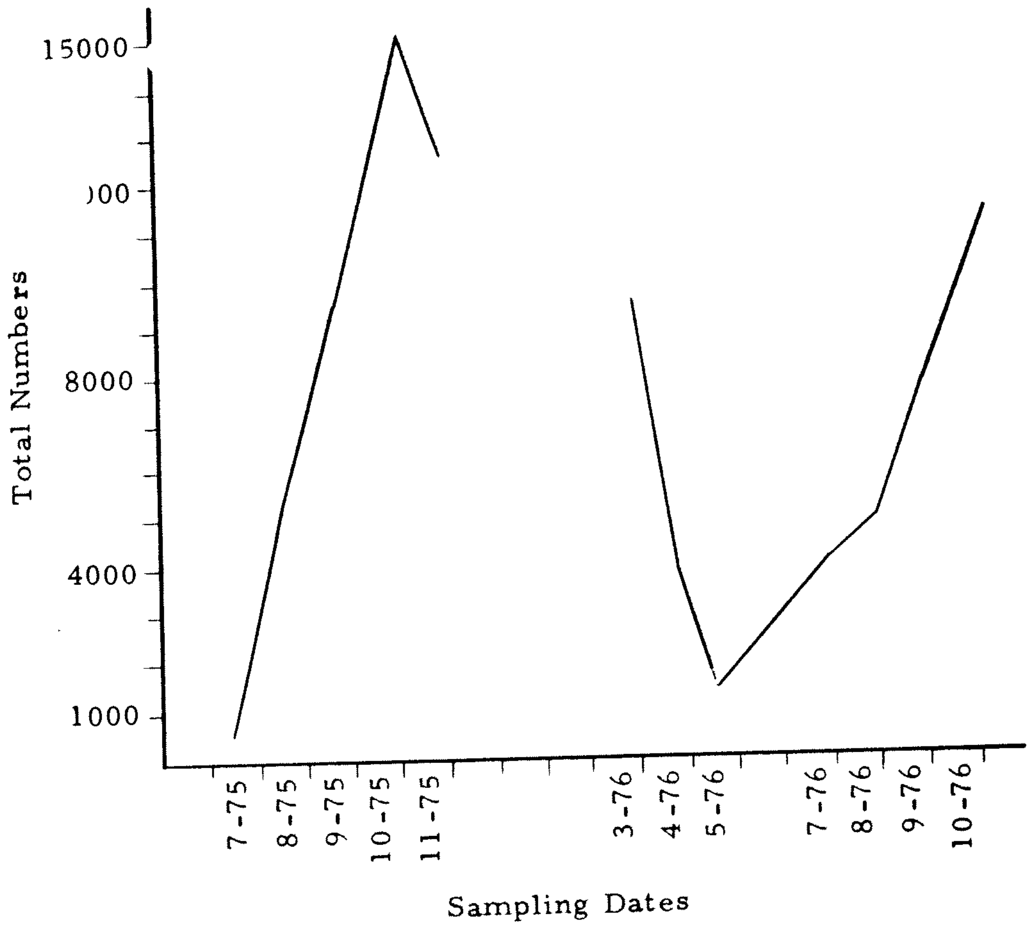



Figure 17. Seasonal changes in total abundance of aquatic insects on the Yampa River, July 1975 to October 1976.

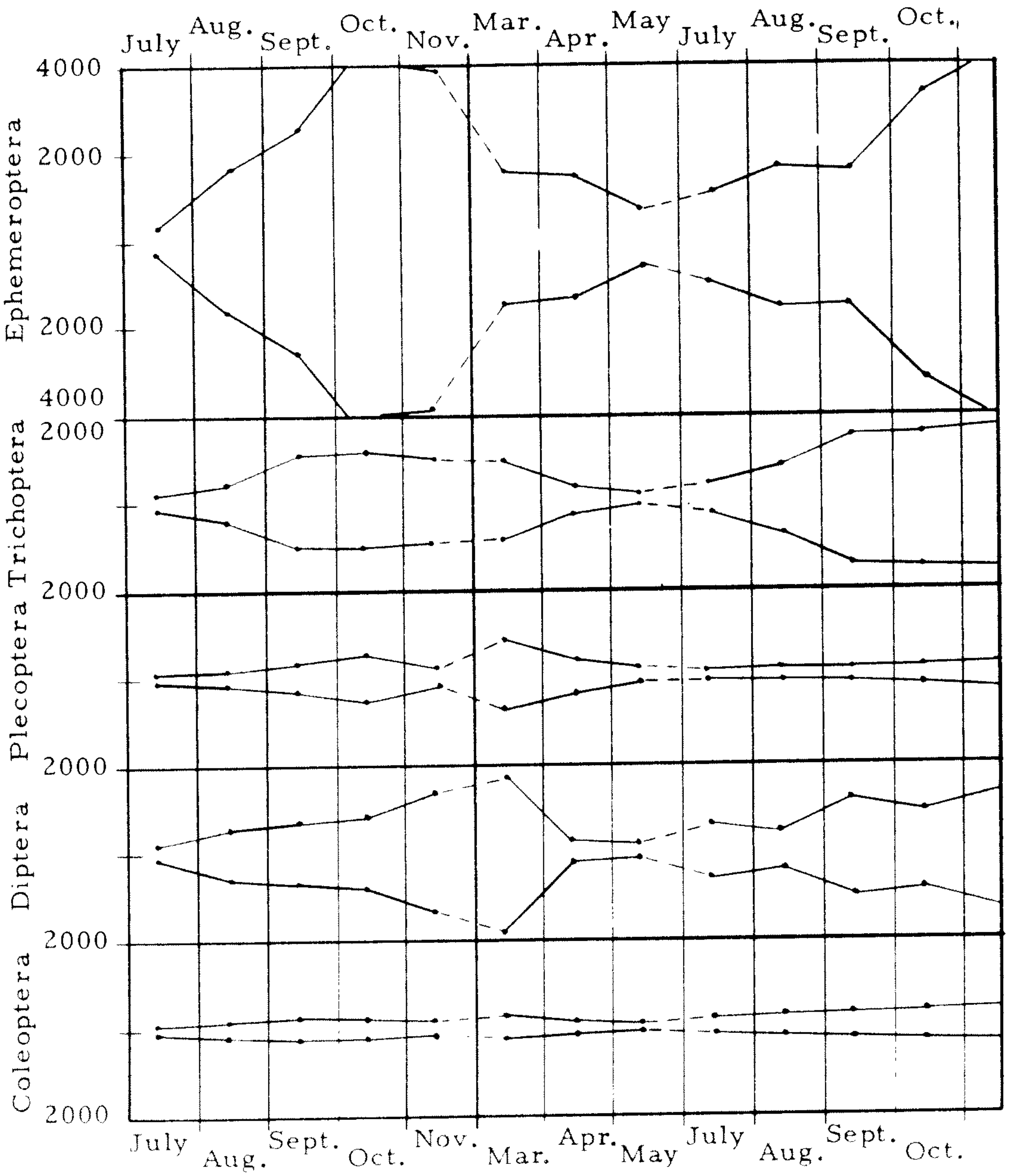



Figure 18. Seasonal change in abundance of the major orders of aquatic insects of the Yampa River, July 1975 to October 1976.

Table 36. Seasonal change in total abundance for the major species on the Yampa River (total from Sites Y3, Y4, and Y5).

| Taxon | Monthly Sampling Dates | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7/75 | 8/75 | 9/75 | 10/75 | 11/75 | 3/76 | 4/76 | 5/76 | 7/76 | 8/76 | 9/76 | 10/76 | |
| EPHEMEROPTERA | | | | | | | | | | | | | |
| Polymitarcidae | | | | | | | | | | | | | |
| *Ephoron album* | 44 | 449 | 46 | 29 | 0 | 0 | 0 | 0 | 89 | 46 | 3 | 0 | 706 |
| Ephemeridae | | | | | | | | | | | | | |
| *Ephemera simulans* | 3 | 4 | 1 | 35 | 12 | 50 | 10 | 1 | 9 | 30 | 12 | 16 | 183 |
| Leptophlebiidae | | | | | | | | | | | | | |
| *Choroterpes albiannulata* | 0 | 613 | 174 | 18 | 0 | 0 | 1 | 0 | 305 | 358 | 36 | 6 | 1,511 |
| *Traverella albertana* | 0 | 16 | 5 | 0 | 0 | 0 | 0 | 0 | 62 | 52 | 0 | 0 | 135 |
| Baetidae | | | | | | | | | | | | | |
| *Beatis* sp. | 342 | 968 | 868 | 53 | 79 | 687 | 381 | 700 | 996 | 707 | 434 | 176 | 6,391 |
| Tricorythidae | | | | | | | | | | | | | |
| *Tricorythodes minutus* | 125 | 919 | 408 | 1338 | 2501 | 1013 | 194 | 8 | 510 | 1492 | 738 | 3575 | 12,821 |
| Heptageniidae | | | | | | | | | | | | | |
| *Rhithrogena* sp. | 6 | 114 | 1980 | 1551 | 859 | 187 | 483 | 201 | 47 | 118 | 375 | 194 | 6,115 |
| *Heptagenia* sp. | 33 | 51 | 20 | 14 | 23 | 7 | 2 | 2 | 48 | 39 | 48 | 62 | 349 |
| Ephemerellidae | | | | | | | | | | | | | |
| *Ephemerella inermis* | 31 | 40 | 1539 | 7363 | 4521 | 1163 | 1648 | 422 | 25 | 14 | 955 | 2890 | 20,611 |
| | | | | | | | | | | | | | 48,822 |
| TRICHOPTERA | | | | | | | | | | | | | |
| Hydropsychidae | | | | | | | | | | | | | |
| *Hydropsyche* sp. | 57 | 503 | 662 | 581 | 559 | 620 | 83 | 28 | 212 | 512 | 563 | 305 | 4,685 |
| *Cheumatopsyche* sp. | 64 | 254 | 1203 | 1128 | 833 | 796 | 204 | 32 | 183 | 745 | 1262 | 1635 | 8,339 |
| Brachycentridae | | | | | | | | | | | | | |
| *Brachycentrus* sp. | 28 | 13 | 5 | 5 | 8 | 0 | 5 | 0 | 7 | 2 | 9 | 2 | 84 |
| Hydroptilidae | | | | | | | | | | | | | |
| *Hydroptila* sp. | 4 | 34 | 8 | 52 | 66 | 13 | 0 | 0 | 129 | 23 | 16 | 253 | 598 |
| Leptoceridae | | | | | | | | | | | | | |
| *Oecetis* sp. | 17 | 20 | 258 | 356 | 135 | 139 | 1 | 35 | 6 | 168 | 753 | 513 | 2,401 |
| *Triaenodes* sp. | 0 | 3 | 7 | 26 | 6 | 8 | 5 | 0 | 0 | 19 | 15 | 37 | 126 |
| Lepidostomatidae | | | | | | | | | | | | | |
| *Lepidostoma* sp. | 0 | 0 | 0 | 18 | 1 | 0 | 16 | 1 | 0 | 0 | 0 | 1 | 37 |
| Glossosomatidae | | | | | | | | | | | | | |
| *Protoptila* sp. | 9 | 9 | 87 | 11 | 7 | 4 | 1 | 0 | 12 | 42 | 222 | 126 | 530 |
| | | | | | | | | | | | | | 16,800 |

Table 36. Continued.

| Taxon | Monthly Sampling Dates | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7/75 | 8/75 | 9/75 | 10/75 | 11/75 | 3/76 | 4/76 | 5/76 | 7/76 | 8/76 | 9/76 | 10/76 | |
| PLECOPTERA | | | | | | | | | | | | | |
| Perlodidae | | | | | | | | | | | | | |
| _Isoperla_ sp. | 0 | 204 | 157 | 780 | 136 | 138 | 465 | 79 | 8 | 1 | 14 | 93 | 2,075 |
| _Isogenus_ sp. | 1 | 8 | 134 | 132 | 76 | 51 | 30 | 13 | 22 | 66 | 49 | 36 | 618 |
| Perlidae | | | | | | | | | | | | | |
| _Claassenia sabulosa_ | 16 | 16 | 236 | 156 | 39 | 19 | 0 | 3 | 26 | 68 | 45 | 4 | 628 |
| Chloroperlidae | | | | | | | | | | | | | |
| _Alloperla_ sp. | 3 | 0 | 0 | 0 | 181 | 103 | 71 | 35 | 1 | 0 | 1 | 28 | 423 |
| Pteronarcidae | | | | | | | | | | | | | |
| _Pteronarcella badia_ | 1 | 23 | 134 | 60 | 35 | 60 | 16 | 0 | 8 | 0 | 0 | 1 | 337 |
| Nemouridae | | | | | | | | | | | | | |
| _Brachyptera_ sp. | 0 | 0 | 0 | 0 | 24 | 295 | 32 | 0 | 0 | 0 | 0 | 0 | 351 |
| _Capnia_ sp. | 0 | 0 | 0 | 0 | 0 | 676 | 1 | 0 | 0 | 0 | 0 | 0 | 677 |
| | | | | | | | | | | | | | 5,109 |
| COLEOPTERA | | | | | | | | | | | | | |
| Elmidae | | | | | | | | | | | | | |
| _Microcylleopis_ sp. | 1 | 8 | 12 | 6 | 16 | 32 | 5 | 0 | 0 | 20 | 13 | 3 | 116 |
| _Zaitzevia_ sp. | 16 | 60 | 204 | 76 | 14 | 74 | 13 | 2 | 79 | 92 | 112 | 68 | 810 |
| _Dubiraphia_ sp. | 5 | 33 | 14 | 32 | 38 | 42 | 50 | 3 | 8 | 18 | 13 | 131 | 387 |
| _Optioservus_ sp. | 4 | 61 | 81 | 90 | 44 | 56 | 6 | 2 | 14 | 39 | 116 | 85 | 598 |
| | | | | | | | | | | | | | 1,911 |
| DIPTERA | | | | | | | | | | | | | |
| Rhagionidae | | | | | | | | | | | | | |
| _Atherix variegata_ | 12 | 155 | 472 | 268 | 142 | 314 | 31 | 11 | 53 | 107 | 128 | 81 | 1,874 |
| Tipulidae | | | | | | | | | | | | | |
| _Hexatoma_ sp. | 19 | 95 | 174 | 224 | 72 | 49 | 49 | 13 | 63 | 29 | 95 | 66 | 948 |
| Simuliidae larvae | 29 | 25 | 244 | 33 | 37 | 352 | 44 | 13 | 187 | 64 | 49 | 15 | 1,092 |
| Chironomidae larvae | 20 | 771 | 363 | 1233 | 2424 | 2797 | 258 | 57 | 964 | 394 | 2035 | 1747 | 12,973 |
| | | | | | | | | | | | | | 15,187 |
| LEPIDOPTERA | | | | | | | | | | | | | |
| Pyralidae | | | | | | | | | | | | | |
| _Cataclysta_ sp. | 1 | 0 | 4 | 1 | 1 | 8 | 1 | 0 | 0 | 17 | 28 | 8 | 69 |

Alloperla sp. was also very abundant in the spring. All other stonefly species showed the general trend.

True flies also showed a higher peak in the spring of 1976 than in the fall of either 1975 or 1976. This was primarily due to the abundance of Chironomidae and Simuliidae, which have many spring-emerging species. Atherix variegata and Hexatoma sp. followed the general seasonal pattern. Beetles, mainly Elmidae, followed the same pattern, but were less abundant than the other major orders (Figure 18). The seasonal change in percentage composition of aquatic insects of the Yampa River is illustrated in Figure 19. Mayflies were the most common order throughout the year except in the early spring. In March, mayflies made up 32% while true flies comprised 36% of the fauna. Stoneflies became much more abundant in March and comprised 14% of the fauna.

All orders except the principle component, mayflies, from the White River exhibited the seasonal trends outlined by Hynes (1970) and observed for the Yampa River (Figure 20). With respect to total abundance there was generally an increase in numbers from July through November 1975. A peak, followed by a drop in abundance occurred in the spring of 1976. The greatest peak, in July 1976, was caused primarily by a surge in numbers of Tricorythodes minutus, Choroterpes albiannulata, and Traverella albertana (Figure 21 and Table 37). These species are adapted to a substrate mixed with silt (Berner, 1959), and the observed change in abundance may be explained by an increase in silt caused by the building of a bridge just upstream from Site W1. Yet, Baetis sp. was also very abundant at that time.

From the high peak in total numbers in July 1976, there was a decrease to September 1976 to a level almost that of September 1975. White River stoneflies were most abundant in November, March, and April; this was due to the abundance of the genus Isoperla.

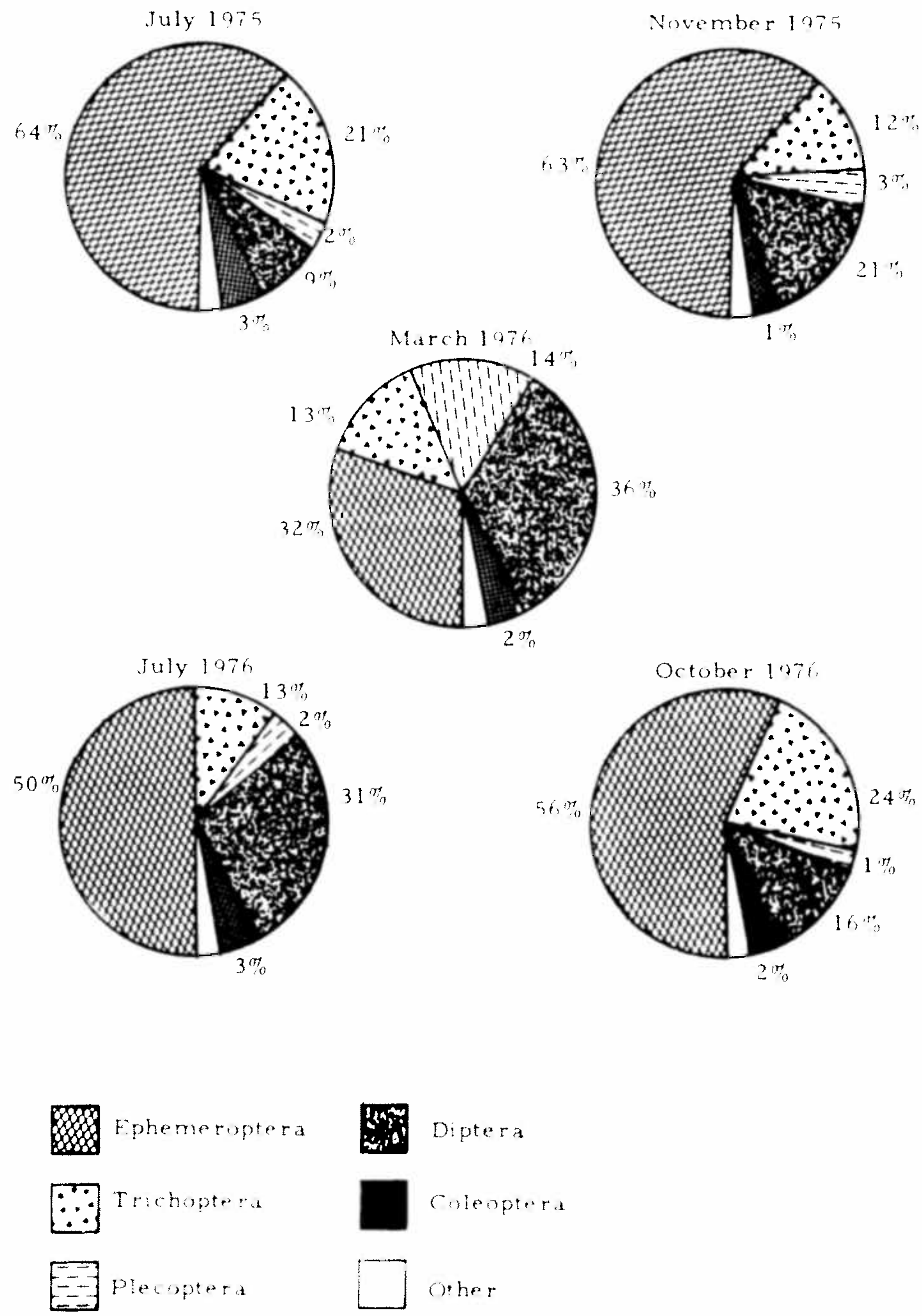



Figure 19. Seasonal change in percentage composition of the major orders of aquatic insects of the Yampa River, Colorado.

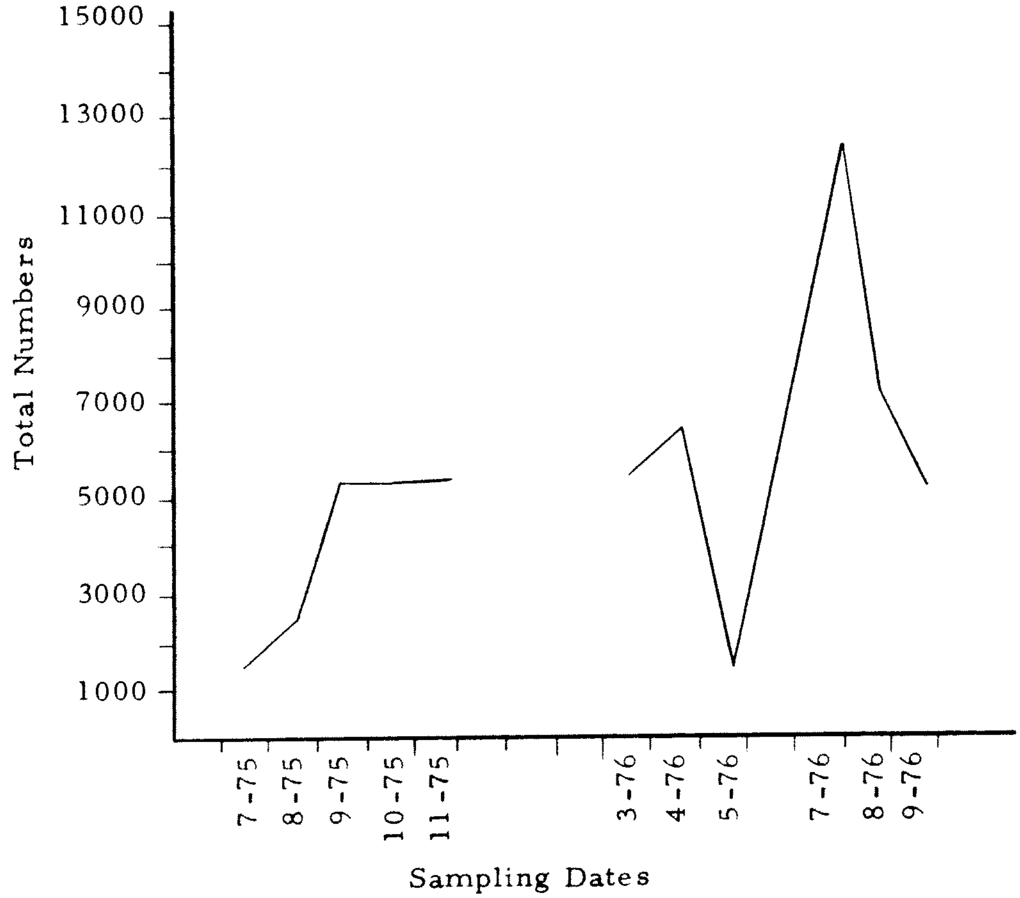



Figure 20. Seasonal changes in total abundance of aquatic insects on the White River, July 1975 to October 1976.

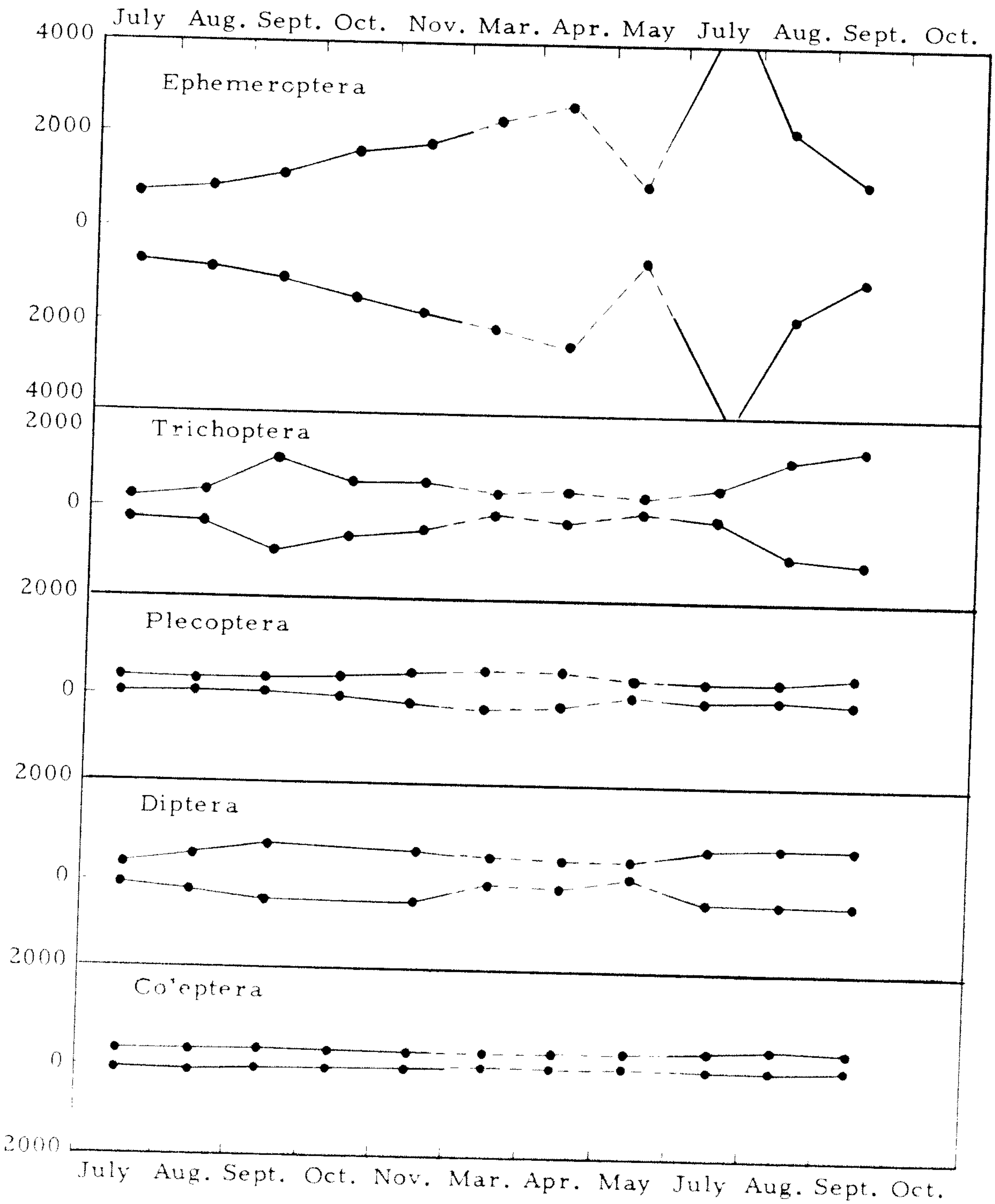



Figure 21. Seasonal change in total abundance of the major orders of aquatic insects of the White River, July 1975 to September 1976.

Table 37. Seasonal change in total abundance for the major species on the White River (total from Sites W1, W2, and W3).

| Taxon | Monthly Sampling Dates | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7/75 | 8/75 | 9/75 | 10/75 | 11/75 | 3/76 | 4/76 | 5/76 | 7/76 | 8/76 | 9/76 | Total |
| EPHEMEROPTERA | | | | | | | | | | | | |
| Polymitarcidae | | | | | | | | | | | | |
| *Ephoron album* | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 2 | 0 | 15 |
| Leptophlebiidae | | | | | | | | | | | | |
| *Choroterpes albiannulata* | 0 | 89 | 51 | 2 | 0 | 0 | 0 | 0 | 914 | 189 | 18 | 1,263 |
| *Traverella albertana* | 1 | 17 | 63 | 33 | 0 | 0 | 0 | 0 | 604 | 188 | 5 | 911 |
| Baetidae | | | | | | | | | | | | |
| *Baetis* sp. | 327 | 1099 | 1051 | 419 | 360 | 850 | 415 | 87 | 1744 | 1248 | 798 | 8,398 |
| Tricorythidae | | | | | | | | | | | | |
| *Tricorythodes minutus* | 484 | 119 | 273 | 305 | 251 | 72 | 115 | 40 | 6882 | 2196 | 492 | 11,229 |
| Heptagenidae | | | | | | | | | | | | |
| *Rhithrogena* sp. | 71 | 5 | 109 | 387 | 451 | 140 | 112 | 12 | 115 | 37 | 20 | 1,459 |
| *Heptagenia* sp. | 110 | 4 | 44 | 50 | 13 | 29 | 21 | 1 | 123 | 113 | 72 | 581 |
| Ephemerellidae | | | | | | | | | | | | |
| *Ephemerella* sp. | 265 | 0 | 596 | 1490 | 2133 | 3412 | 4326 | 1259 | 349 | 166 | 382 | 14,378 |
| | | | | | | | | | | | | 38,234 |
| TRICHOPTERA | | | | | | | | | | | | |
| Hydropsychidae | | | | | | | | | | | | |
| *Hydropsyche* sp. | 174 | 422 | 1728 | 595 | 607 | 124 | 509 | 38 | 105 | 1179 | 1051 | 6,532 |
| *Cheumatopsyche* sp. | 1 | 34 | 119 | 204 | 122 | 36 | 57 | 17 | 78 | 811 | 1068 | 2,547 |
| Brachycentridae | | | | | | | | | | | | |
| *Brachycentrus* sp. | 13 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 25 | 5 | 45 |
| Hydroptilidae | | | | | | | | | | | | |
| *Hydroptila* sp. | 27 | 40 | 6 | 31 | 51 | 1 | 0 | 0 | 231 | 90 | 184 | 661 |
| Leptoceridae | | | | | | | | | | | | |
| *Oecetis* sp. | 3 | 0 | 1 | 18 | 8 | 0 | 1 | 0 | 0 | 6 | 19 | 56 |
| *Triaenodes* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Lepidostomatidae | | | | | | | | | | | | |
| *Lepidostoma* sp. | 0 | 0 | 0 | 1 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 10 |
| Glossosomatidae | | | | | | | | | | | | |
| *Protoptila* sp. | 0 | 0 | 6 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 24 | 33 |
| | | | | | | | | | | | | 9,885 |

Table 37. Continued.

| Taxon | Monthly Sampling Dates | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7/75 | 8/75 | 9/75 | 10/75 | 11/75 | 3/76 | 4/76 | 5/76 | 7/76 | 8/76 | 9/76 | |
| PLECOPTERA | | | | | | | | | | | | |
| Perlodidae | | | | | | | | | | | | |
| *Isoperla* sp. | 68 | 2 | 9 | 144 | 330 | 513 | 394 | 44 | 21 | 9 | 47 | 1,581 |
| *Isogenus* sp. | 0 | 1 | 11 | 37 | 28 | 22 | 67 | 8 | 47 | 25 | 26 | 272 |
| Perlidae | | | | | | | | | | | | |
| *Claassenia sabulosa* | 4 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Chloroperlidae | | | | | | | | | | | | |
| *Alloperla* sp. | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 4 | 0 | 3 | 1 | 44 |
| Pteronarcidae | | | | | | | | | | | | |
| *Pteronarcella badia* | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| Nemouridae | | | | | | | | | | | | |
| *Brachyptera* sp. | 0 | 0 | 0 | 0 | 134 | 1 | 0 | 0 | 0 | 0 | 0 | 135 |
| *Capnia* sp. | 0 | 0 | 0 | 0 | 0 | 43 | 0 | 0 | 0 | 0 | 0 | 43 |
| | | | | | | | | | | | | 2,091 |
| COLEOPTERA | | | | | | | | | | | | |
| Elmidae | | | | | | | | | | | | |
| *Microcylleopis* sp. | 14 | 16 | 38 | 40 | 16 | 24 | 19 | 6 | 34 | 92 | 35 | 334 |
| *Zaitzevia* sp. | 6 | 16 | 10 | 10 | 13 | 4 | 5 | 9 | 24 | 11 | 18 | 126 |
| *Dubiraphia* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 7 | 0 | 6 | 0 | 4 | 18 |
| *Optioservus* sp. | 2 | 2 | 9 | 1 | 0 | 4 | 6 | 1 | 0 | 1 | 0 | 26 |
| | | | | | | | | | | | | 504 |
| DIPTERA | | | | | | | | | | | | |
| Rhagionidae | | | | | | | | | | | | |
| *Atherix variegata* | 4 | 10 | 63 | 31 | 15 | 17 | 39 | 14 | 3 | 3 | 10 | 209 |
| Tipulidae | | | | | | | | | | | | |
| *Hexatoma* sp. | 36 | 81 | 270 | 73 | 64 | 86 | 50 | 5 | 60 | 121 | 107 | 953 |
| Simuliidae larvae | 19 | 215 | 81 | 58 | 86 | 58 | 5 | 8 | 283 | 215 | 39 | 1,064 |
| Chironomidae larvae | 96 | 410 | 632 | 0 | 830 | 177 | 181 | 9 | 481 | 543 | 679 | 4,038 |
| | | | | | | | | | | | | 6,075 |
| LEPIDOPTERA | | | | | | | | | | | | |
| Pyralidae | | | | | | | | | | | | |
| *Cataclysta* sp. | 7 | 2 | 128 | 69 | 17 | 21 | 38 | 1 | 0 | 25 | 24 | 332 |

## Aquatic insect diversity

The median Shannon-Weaver Diversity Index value by dates for all of the Yampa River sites was close to 3.00, except for the slightly higher value for Site Y1 (Table 38). The lower sites (Y4, Y5 and Y6) showed a greater range of diversity than Sites Y1, Y2 and Y3, indicating that the former sites experienced greater fluctuations in environmental conditions during the sampling period. Sites Y1, Y2 and Y3 had a similar range of diversity index values and were apparently affected to a similar degree by environmental conditions. Index values for Site Y4 were variable but generally indicated a favorable environment for aquatic insects. The median diversity values for the Yampa River indicated clean water according to the definitions of Wilhm and Dorris (1968). The highest diversity values occurred in August and September 1975 and 1976 (Table 38). In theory, that was the time of the year when environmental conditions should have been most stable. The water was low, slow and clear, and temperatures were moderate. Only a few species were emerging, and abundance was increasing. The lowest diversity values were calculated for the May 1976 collections. Environmental conditions were unstable; run-off was occurring, and the water was fast and turbid. At that time of year, many species emerged and numbers declined.

Diversity values were generally lower for White River sites than for Yampa River sites (Table 39). W1A, the highest in elevation, showed a median index value of 3.16, indicating clean water, and a wide range of values (1.58-3.28), indicating fluctuating conditions. Sites W1, W2 and W3 had median diversity values of less than 3.0, indicating general water quality degradation. As on the Yampa River, the highest diversity was in the fall and the lowest in the spring (Table 39).

Table 38. Total number of insect species, range of values for the Shannon-Weaver Diversity Index, and seasonal diversity values for the sampling sites on the Yampa River, Colorado.

| | Sampling Sites | | | | | |
|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 |
| Total taxa | 70 | 64 | 77 | 70 | 66 | 61 |
| Shannon-Weaver values | | | | | | |
| August 1975 | 3.78 | 3.70 | 3.08 | 4.17 | 3.27 | -- |
| September 1975 | 3.43 | 3.19 | 3.29 | 3.43 | 3.16 | -- |
| May 1976 | 2.48 | 2.75 | 2.88 | 1.51 | 1.60 | -- |
| August 1976 | -- | -- | 3.70 | 3.05 | 3.00 | 3.31 |
| September 1976 | -- | -- | 3.30 | 3.53 | 3.40 | 3.50 |
| Range for all sampling dates | 2.95-3.78 | 2.42-3.70 | 2.75-3.70 | 2.30-4.17 | 1.51-3.60 | 1.60-3.62 |
| Median value | 3.43 | 2.85 | 3.00 | 2.91 | 3.00 | 3.15 |

Table 39. Total number of species, range of values for the Shannon-Weaver Diversity Index, and seasonal diversity values for the sites on the White River, Colorado.

| | Sampling Sites | | | |
|---|---|---|---|---|
| | W1A | W1 | W2 | W3 |
| Total taxa | 61 | 58 | 46 | 59 |
| Shannon-Weaver values | | | | |
| August 1975 | 3.24 | 2.62 | 2.99 | 2.25 |
| September 1975 | 3.27 | 2.40 | 2.43 | 3.31 |
| May 1976 | 1.58 | 1.30 | 1.74 | 0.61 |
| August 1976 | -- | 3.05 | 3.24 | 2.95 |
| September 1976 | -- | 2.89 | 2.88 | 3.45 |
| Range for all sampling dates | 1.58-3.28 | 1.30-3.06 | 1.74-3.24 | 0.61-3.45 |
| Median value | 3.26 | 2.62 | 2.43 | 2.74 |

## Statistical analysis of aquatic insect data

Analysis of variance of total numbers of aquatic insects by dates and Yampa River sampling sites showed highly-significant differences among both sampling sites and dates (Table 40). The F-statistic for a cubic relationship among dates was also highly significant. The test statistic for differences between Yampa River sampling sites was also highly significant as was the test for a quadratic trend (i.e. one peak).

Seasonal abundance trends were not verified by a similar analysis of White River data (Table 41), but differences between White River sampling sites were also statistically significant. The most significant trend was linear, indicating that numbers gradually decreased from Site W1A to Site W3.

## Aquatic macroinvertebrates other than insects

Distribution and total numbers of non-insect macroinvertebrates collected from the Yampa and White Rivers are presented in Tables 42 and 43. Oligochaete worms were the most common non-insect invertebrates in both rivers; greatest numbers were found at Sites Y4 and W2. The substrate at these sites was mixed coarse and fine material.

Hydracarina were generally common at the upper sites and scarce at the lower sites on both rivers. Ferrissia sp., a limpet, was found only in the Yampa River, while amphipod crustaceans were found only in the White River.

Table 40. Analysis of variance table for the sampling sites and dates on the Yampa River, Colorado.

| Source of Variation | Degrees of Freedom | Sums of Squares | Mean Square | F-Statistic |
|---|---|---|---|---|
| Between dates | 11 | 26424139 | 2402194 | 4.427 |
| Cubic | 1 | 22520452 | 22520452 | 41.499 |
| Between sites | 4 | 23037075 | 5759269 | 10.613 |
| Quadratic | 1 | 7087922 | 7087922 | 13.061 |
| Residual | 35 | 18993506 | 542672 | |

Table 41. Analysis of variance table for the sampling sites and dates on the White River, Colorado.

| Source of Variation | Degrees of Freedom | Sums of Squares | Mean Square | F-Statistic |
|---|---|---|---|---|
| Between dates | 10 | 6714267 | 671427 | 1.797 |
| Between sites | 3 | 8890532 | 2963511 | 7.933 |
| Linear | 1 | 4207170 | 4207170 | 11.263 |
| Residual | 27 | 10085888 | 373551 | |

Table 42. Distribution and total numbers of macroinvertebrates other than insects collected from the Yampa River, Colorado, July 1975 to October 1976.

| Taxon | Sampling Site | | | | | |
|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 |
| Gastropoda<br>Planorbidae<br>*Gyraulus* sp. | 0 | 0 | 0 | 4 | 0 | 0 |
| Physidae<br>*Physa* sp. | 1 | 1 | 0 | 0 | 10 | 2 |
| Ancylidae<br>*Ferrissia* sp. | 0 | 0 | 13 | 41 | 9 | 1 |
| Pelecypoda<br>Sphaeriidae<br>*Sphaerium* sp. | 0 | 0 | 0 | 0 | 1 | 2 |
| Annelida<br>Oligochaeta | 2 | 21 | 18 | 276 | 2 | 13 |
| Hirudinea<br>Glossiphoniidae | 0 | 0 | 1 | 0 | 0 | 0 |
| Hydracarina | 21 | 30 | 14 | 1 | 0 | 1 |
| Collembola | 0 | 0 | 0 | 0 | 1 | 0 |
| Cladocera<br>*Daphnia* sp. | 0 | 0 | 0 | 2 | 0 | 0 |

Table 43. Distribution and total numbers of macroinvertebrates other than insects collected from the White River, Colorado, July 1975 to September 1976.

| Taxon | Sampling Site | | | |
|---|---|---|---|---|
| | W1A | W1 | W2 | W3 |
| Gastropoda | | | | |
| Limnaeidae | | | | |
| *Lymnaea* sp. | 4 | 3 | 0 | 1 |
| Physidae | | | | |
| *Physa* sp. | 30 | 3 | 3 | 0 |
| Amphipoda | | | | |
| Gammaridae | | | | |
| *Gammarus* sp. | 21 | 1 | 0 | 1 |
| Talitridae | | | | |
| *Hyalella azteca* | 1 | 1 | 0 | 0 |
| Annelida | | | | |
| Oligochaeta | 4 | 41 | 43 | 14 |
| Hydracarina | 3 | 11 | 6 | 0 |

## HABITAT

### *Methods*

Water chemistry determinations made at the times of fish collections included dissolved oxygen, total hardness, total alkalinity, pH, temperature, and specific conductance. Chemical parameters were measured with either a Hach model AL-36B field kit or a Hach field engineer's kit. Dissolved oxygen was determined by titrating a 200-ml sample (prepared with Hach alkaline-azide-iodine reagents) with 0.025N phenyl arsine oxide (PAO) to an accuracy of 0.01 mg/l. Conductivity was measured with a Beckman conductivity meter.

Specific habitat features of certain stations on both rivers were described qualitatively or by dimensional measurements made during 1976 and 1977. Features assessed qualitatively included bankside vegetation and stability, grazing or other overbank land-use practices and instream activities such as channelization, stabilization or dredging.

At locations of detailed dimensional measurements, five or six channel cross-sections were surveyed to determine the ground profile. Water surface elevations were determined to within 0.305 cm, and velocities measured to within 0.2 feet per second (0.06 meters per second [mps]). Substrate was described as mud, sand, cobble, rubble (angular cobble) or boulders by visual means. Stream measurements were made in English units to facilitate comparisons with other hydrologic data. Using these data and a U.S. Bureau of Reclamation computer program known as Water Surface Profile (WSP), the depth and velocity characteristics of the site could be predicted with reasonable accuracy for flows higher or lower than those observed. Use of this program in flow-related fisheries studies was described by Spence (1975) and Bovee and Milhaos (1978).

Instream habitat at the sites was then evaluated by substrate and velocity diversity, gradient, mean depth and width, and pool:riffle ratio. These parameters were evaluated at a flow approximating mean annual flow and at a low flow (approximating a 20-year low flow) by computer simulation.

## *Results*

### Chemical and physical conditions

Physical and chemical conditions measured at fish-collecting stations on the Yampa (Table 44) and White (Table 45) Rivers varied within levels suitable for the existence of a diverse fish fauna. Dissolved oxygen levels approximated saturation in both rivers (Tables 44 and 45). Hardness and alkalinity were both relatively high but not unexpectedly so; large rivers flowing over calcific substrate are normally harder than waters emanating from granitic basins (Hynes, 1970). Conductivity was generally higher in the White River than in the Yampa River.

Discharge levels in 1977 were the lowest experienced during our study. Prior to our July 1977 sampling trip, water levels reached extremely low levels in both rivers. USGS records indicated flows of 20 cfs in the Yampa and 50 cfs in the White River. Rainstorms just prior to our July sampling trip restored water levels to nearly normal conditions. Discharge levels in 1975 and 1978 were high; those in 1976 were intermediate. Water temperatures increased during the summer of 1977 at a much faster rate than in previous years.

Table 44. Results of physico-chemical determinations on the Yampa River, 1975-1977.

| Station | Date | Time of Day | Water Temp. (C) | D.O. (mg/liter) | pH | Total Alk. (mg/liter) | Total Hardness (mg/liter) | Cond. (mmhos @25 C) | Turbidity (JTU) |
|---|---|---|---|---|---|---|---|---|---|
| Y-1 | 7/10/75 | -- | 13.9 | 8 | 8 | 34.2 | 51.3 | -- | -- |
| Y-2 | 7/11/75 | -- | 16.1 | 8 | 8 | 42.8 | 51.3 | -- | -- |
| Y-3 | 7/13/75 | -- | 18.9 | 8 | 9 | 47.8 | 68.4 | 280 | -- |
| Y-4 | 7/14/75 | -- | 18.9 | 9 | 9 | 68.4 | 85.5 | 300 | -- |
| Y-1 | 7/19/75 | -- | 14.7 | 8 | 8 | 41.6 | 85.5 | 237 | -- |
| Y-2 | 7/19/75 | -- | 16.4 | 9 | 9 | 47.9 | 68.4 | 265 | -- |
| Y-3 | 7/19/75 | -- | 20.5 | 8 | 9 | 54.7 | 85.5 | 343 | -- |
| Y-4 | 7/19/75 | -- | 20.0 | 8 | 9 | 61.6 | 85.5 | 356 | -- |
| Y-1 | 8/5/75 | -- | 22.6 | 8.51 | 9 | 88.9 | 119.7 | 458 | -- |
| Y-2 | 8/5/75 | -- | 19.4 | 7.89 | 9 | 85.5 | 102.6 | 490 | -- |
| Y-3 | 8/5/75 | -- | 23.3 | 8.2 | 9.5 | 119.7 | 153.9 | 675 | -- |
| Y-4 | 8/5/75 | -- | 23.3 | 7.6 | 9.5 | 119.7 | 153.9 | 700 | -- |
| Y-3 | 8/25/75 | -- | 20 | 8.46 | 9 | 136.8 | 153.9 | 800 | -- |
| Y-4 | 8/25/75 | -- | 18 | 8.10 | 9 | 136.8 | 171 | 940 | -- |
| Y-4 | 8/25/75 | -- | 18 | 8.24 | 9 | 136.8 | 171 | 940 | -- |
| Y-1 | 9/17/75 | -- | 13 | 9.51 | 8.5 | 136.8 | 153.9 | 675 | -- |
| Y-2 | 9/17/75 | -- | 15.5 | -- | 9 | 136.8 | 153.9 | 825 | -- |
| Y-3 | 9/17/75 | -- | 18 | 8.56 | 9 | 171 | 188.1 | 1100 | -- |
| Y-4 | 9/17/75 | -- | 16.5 | 8.5 | 9 | 153.9 | 188.1 | 1200 | -- |
| Y-1 | 3/24/76 | 0900 | 0 | 11.9 | 8 | 116 | 154 | 1125 | -- |
| Y-2 | 3/24/76 | 1300 | 0 | 10.6 | 8.5 | 137 | 239 | 1400 | -- |
| Y-3 | 3/24/76 | 1600 | 0 | 10.65 | 8.5 | 55 | 145 | 1500 | -- |
| Y-1 | 5/19/76 | 0915 | 8 | 8.65 | -- | 30 | 40 | 180 | 45 |
| Y-2 | 5/19/76 | 1230 | 12 | 8 | -- | 30 | 40 | 220 | 75 |
| Y-3 | 5/19/76 | 1545 | 14.5 | 8.2 | 7.75 | 100 | 125 | 270 | 75 |
| Y-4 | 5/20/76 | 1130 | 14 | 8.6 | 7.6 | 80 | 80 | 305 | 140 |
| Y-1 | 6/1/76 | 0900 | 9.5 | 9.1 | 7.2 | 25 | 35 | 160 | 15 |
| Y-2 | 6/1/76 | 1200 | 12 | 8.6 | 7.2 | 35 | 35 | 180 | 15 |
| Y-3 | 6/1/76 | 1700 | 15 | 8.5 | 7.4 | 53 | 60 | 280 | 45 |
| Y-4 | 6/2/76 | 1200 | 15 | 9.0 | 7.4 | 55 | 60 | 280 | 60 |
| Y-1 | 6/22/76 | 0645 | 15 | 7.6 | 7.4 | 32 | 42 | 160 | 10 |
| Y-2 | 6/22/76 | 1230 | 16 | 7.6 | 7.7 | 44 | 52 | 220 | 12 |
| Y-3 | 6/22/76 | 1745 | 18 | 7.6 | 7.8 | 64 | 72 | 410 | 275 |
| Y-4 | 6/23/76 | 1050 | 18 | 8.0 | 7.8 | 80 | 110 | 375 | >500 |
| Y-1 | 7/15/76 | 1400 | 21 | 8.55 | -- | 60 | 70 | 340 | -- |
| Y-2 | 7/15/76 | 1800 | 24 | 7.75 | -- | 65 | 72 | 360 | -- |
| Y-3 | 7/16/76 | 1000 | 22 | 7.0 | -- | 90 | 100 | 560 | -- |
| Y-4 | 7/16/76 | 1600 | 24 | 8.2 | -- | 100 | 100 | 600 | -- |

Table 44.—Continued.

| Station | Date | Time of Day | Water Temp. (C) | D.O. (mg/liter) | pH | Total Alk. (mg/liter) | Total Hardness (mg/liter) | Cond. (mmhos @25 C) | Turbidity (JTU) |
|---|---|---|---|---|---|---|---|---|---|
| Y-1 | 8/4/76 | 1300 | 20 | 8.85 | 7.5 | 95 | 100 | 475 | -- |
| Y-2 | 8/4/76 | 1700 | 22 | 8.85 | 7.5 | 95 | 100 | 540 | -- |
| Y-3 | 8/5/76 | 0900 | 18 | 6.45 | 7.0 | 140 | 161 | 850 | -- |
| Y-4 | 8/5/76 | 1300 | 22 | 8.05 | 7.5 | 155 | 185 | 1050 | -- |
| Y-1 | 10/10/76 | 1400 | 12 | 9.8 | -- | 120 | 120 | 550 | -- |
| Y-4 | 10/10/76 | 0830 | 8 | 9.2 | 8.3 | 160 | 230 | 1200 | -- |
| Y-1 | 5/25/77 | 1335 | 11 | 8.7 | -- | 40 | 35 | 240 | -- |
| Y-2J | 5/25/77 | 1715 | 16 | 8.2 | -- | 70 | 60 | 370 | -- |
| Y-3 | 5/26/77 | 0815 | 13 | 7.9 | -- | 65 | 70 | 375 | -- |
| Y-4 | 5/26/77 | 1130 | 14 | 8.4 | -- | 90 | 80 | 425 | -- |
| Y-1 | 6/27/77 | 1430 | -- | -- | -- | 140 | 140 | 480 | -- |
| Y-2J | 6/27/77 | 1630 | 25.5 | 6.9 | -- | 120 | 120 | -- | -- |
| Y-3 | 6/28/77 | 0930 | 20.5 | 6.3 | -- | 140 | 150 | -- | -- |
| Y-4 | 6/28/77 | 1045 | 22 | 6.75 | -- | 130 | 135 | 805 | -- |
| Y-1 | 7/27/77 | 1600 | 23 | 8.1 | 7.2 | -- | 80 | -- | 30 |
| Y-2J | 7/29/77 | 0730 | 22 | 6.7 | 7.2 | 160 | 110 | -- | -- |
| Y-3 | 7/27/77 | 1000 | 21 | 6.4 | -- | -- | -- | -- | 30 |
| Y-4 | 7/29/77 | 1500 | 22 | 7.3 | 7.3 | 250 | 235 | -- | 130 |
| Y-1 | 8/30/77 | 1400 | 18 | 8.4 | -- | 130 | 120 | -- | -- |
| -2J | 8/30/77 | 1600 | 18 | 7.5 | -- | 170 | 115 | -- | 70 |
| -3 | 8/31/77 | 1100 | 16 | 7.8 | -- | 170 | 120 | -- | 40 |
| -4a | 8/31/77 | 0900 | 13 | 7.5 | -- | 210 | 205 | -- | 140 |

Table 45. Results of physico-chemical determinations on the White River, 1975-197

| Station | Date | Time of Day | Water Temp. (C) | D.O. (mg/liter) | pH | Total Alk. (mg/liter) | Total Hardness (mg/liter) | Cond. (mmhos @25 C) | Turbidi (JTU) |
|---|---|---|---|---|---|---|---|---|---|
| W-A | 7/10/75 | -- | 16.1 | 8 | 9 | 116.3 | 153.9 | 735 | -- |
| W-B | 7/10/75 | -- | 21.6 | 8 | 9.5 | 136.8 | 188.1 | 790 | -- |
| W-A | 7/21/75 | -- | 17.2 | 8 | 9 | 153.9 | 222.3 | 915 | -- |
| W-B | 7/21/75 | -- | 21.4 | 8 | 9.5 | 171 | 239.4 | 1110 | -- |
| W-A | 8/5/75 | -- | 18.6 | 9.2 | 9.5 | 188.1 | 290.7 | 1200 | -- |
| W-B | 8/5/75 | -- | 24.4 | 8.2 | 9.5 | 205.2 | 307.8 | 1400 | -- |
| W-B | 8/27/75 | -- | 19 | 7.9 | 9 | 136.8 | 256.5 | 1500 | -- |
| W-B | 9/19/75 | -- | 25.5 | 7.9 | 9 | 196.7 | 290.7 | 1500 | -- |
| W-A | 5/20/76 | 0945 | 8 | 8.8 | 7.7 | 105 | 120 | 600 | 145 |
| W-B | 5/21/76 | 1545 | 14 | 8.65 | 8.2 | 115 | 145 | 600 | 150 |
| W-A | 6/3/76 | 1045 | 12 | 8.75 | 8.1 | 100 | 130 | 600 | 15 |
| W-B | 6/2/76 | 1645 | 17 | 8.8 | 7.4 | 120 | 160 | 750 | 35 |
| W-A | 6/24/76 | 0745 | 12.5 | -- | 8.05 | 135 | 180 | 875 | 15 |
| W-B | 6/23/76 | 1500 | 18 | 7.5 | -- | 250 | 245 | 1300 | 7500 |
| W-A | 7/17/76 | 0930 | 18.5 | 8.55 | -- | 115 | 320 | 1700 | -- |
| W-B | 7/16/76 | 1900 | 21 | 6.45 | -- | 220 | 300 | 1900 | -- |
| W-A | 8/6/76 | 1600 | 14 | -- | 7.5 | 197 | 302 | 1600 | -- |
| W-B | 8/5/76 | 1900 | 24 | -- | -- | 255 | 362 | 1900 | -- |
| W-A | 8/26/76 | 1200 | 19 | 8.95 | 8.1 | 220 | 320 | 1500 | -- |
| W-B | 8/26/76 | 0900 | 17 | 8.35 | 8.4 | 240 | 360 | 1900 | -- |
| W-A | 5/27/77 | 1130 | 11 | 9.0 | -- | 175 | 270 | 1425 | -- |
| W-B | 5/26/77 | 1515 | 15 | 8.75 | -- | 210 | 270 | 1600 | -- |
| W-A | 6/28/77 | 1715 | 28 | 6.75 | -- | 270 | 350 | 2400 | -- |
| W-B | 6/28/77 | 1430 | 27 | 6.8 | -- | 280 | 310 | 2900 | -- |
| W-A | 7/31/77 | 0800 | 23 | 8.5 | 7.2 | 190 | 230 | -- | 10 |
| W-B | 8/2/77 | 1500 | 25.5 | 8.5 | 7.2 | 240 | 210 | -- | 45 |
| W-A | 8/31/77 | 1400 | 18 | 8.0 | -- | 200 | 240 | -- | 55 |

Typically, water temperatures did not exceed 20 C until July and August. During late June 1977, temperatures were nearly 10 C higher in both rivers than at corresponding dates in previous years of our study.

Results of turbidity analyses in 1975 were considered unreliable because of 1) failure to completely resuspend particulate matter and 2) possible proliferation of phytoplankton in the containers. Use of a Field Engineer's Kit provided acceptable turbidity data in 1976 and 1977. Tests for pH in 1975 and early 1976 were conducted by a simple colorimetric test, and values obtained were probably erroneously high.

Habitat analysis

Traditional pool:riffle analysis of Yampa River habitat was difficult because of the predominance of rather featureless "run" characteristics. The lower Yampa River displayed a "run and crossing" longitudinal profile with long (300-500 m), shallow runs separated by narrow crossing bars as short as approximately 5 m. The majority of the river below Craig, Colorado, is quite similar to cross-sections 0, 220, 419 and 516 measured at Station Y-3 (Table 46 and Appendix VIIa). Only in Juniper and Cross Mountain Canyons and at Station Y-4 were there significantly-different river characteristics. At Station Y-4, a meander had encountered a recent lithologic control, causing a local increase in sinuosity and forming a deep counter-current pool downstream. The result was an area of diverse substrate and velocity distribution (Table 46 and Appendix VIIb).

Winter grazing had destabilized the streambanks near Station Y-3, but its effects were less evident in the vicinity of Station Y-4. Instream activities were evident near Stations Y-1 and Y-3, with bed-material dams

Table [illegible]. Width, depth, width:depth ratio and substrate composition of four representative reaches surveyed on the Yampa and White Rivers, 1976 and 1977.

| Station (and discharge, cfs) | x-sec | Width (ft) | Depth (ft) | Width: Depth | Percent of substrate made up by: Mud | Sand | Cobble | Rubble | Boulders | Velocity category[a] |
|---|---|---|---|---|---|---|---|---|---|---|
| Y-3 | 0 | 150 | 1.5 | 100.0 | | | 100 | | | 2 |
| | 220 | 185 | 4.1 | 45.0 | 20 | | 80 | | | 2 |
| (170) | 419 | 155 | 3.0 | 51.6 | 40 | | 60 | | | 2 |
| | 576 | 135 | 2.7 | 49.3 | 50 | | 50 | | | 2 |
| Gradient = .00010 | 727 | 175 | 5.8 | 29.8 | 80 | | 10 | | 10 | 1 |
| Y-4 | 0 | 150 | 3.0 | 50.0 | | | | | 100 | 3 |
| | 170 | 95 | 3.0 | 31.6 | | 60 | | | 40 | 3 |
| (160) | 446 | 132 | 3.65 | 36.1 | | 60 | | | 40 | 2 |
| | 604 | 220 | 8.0 | 27.5 | | 80 | | | 20 | 1 |
| Gradient = .00015 | 740 | 225 | 7.2 | 31.4 | | 90 | | | 10 | 1 |
| W-A | 0 | 80 | 2.3 | 35.8 | | | 10 | 10 | 80 | 4 |
| | 75 | 96 | 3.8 | 25.3 | 20 | 20 | --------unknown-------- | | | 3 |
| (209) | 238 | 67 | 4.2 | 15.9 | 20 | 20 | --------unknown-------- | | | 1 |
| | 318 | 46 | 6.7 | 6.86 | 20 | 20 | --------unknown-------- | | | 1 |
| Gradient = .0014 | 409 | 65 | 4.2 | 15.47 | 10 | 10 | 80 | | | 1 |
| W-B | 0 | 45 | 2.0 | 22.7 | 10 | | 80 | | 10 | 3 |
| | 80 | 70 | 1.7 | 41.6 | 10 | | 80 | | 10 | 3 |
| (200) | 166 | -- | -- | 25.0 | 10 | | 80 | | 10 | 2 |
| | 261 | -- | -- | 29/19[b] | 10 | | 80 | | 10 | 2 |
| Gradient = .0025 | 360 | -- | -- | 40/16[b] | 10 | | 80 | | 10 | 2 |

[a]Velocity category 1 = < 1 fps (<.304 mps)
2 = > 1 < 2 fps ( > .304 < .608 mps)
3 = > 2 < 3 fps ( > .608 < .912 mps)
4 = > 3 fps ( > .912 mps)

[b]Channel divided by island; numbers denote width:depth ratio on two sides of the island.

constructed to create pools for pumped diversion. Width:depth ratios at Station Y-3 were high, reflecting the broad, shallow nature of the channel. At Station Y-4, width:depth ratios decreased as a result of the pool conditions.

At both White River stations, hydraulic gradients were approximately ten times greater than those measured at either Yampa River station (Table 46 and Appendices VIIc and d). Consequently, velocities were greater and substrate particles larger and more diverse. Again, pool:riffle ratio analysis was difficult because of the predominance of run-crossing characteristics, but riffle areas were more numerous within the White River reaches. Width: depth ratios were commonly less than half those encountered on the Yampa River, again in accordance with the measured hydraulic gradients.

Much winter grazing occurred along the White River near Stations W-A and W-B, and efforts of the landowners to stabilize streambanks were evident. Limited channelization and instream activity were noted. Bankside vegetation was denser near the White than near the Yampa River; a feature normally associated with increased bank stability.

## DISCUSSION

Our fish sampling on the White River in Colorado yielded no species which had not previously been reported. The only discrepancies between our species list (Table 10) and the list of fishes previously reported from the White River in Colorado (Table 2) involve reports by others of species which we did not collect. We undoubtedly missed certain salmonid species by restricting our collecting to lower elevations. We question whether longnose dace and white suckers are or ever were present in the White River. The former was reported by researchers on Colorado Oil Shale Tract C-a (Gulf Oil Corp.

and Standard Oil Co. 1975-77) who included longnose dace in a combined list of species collected from the White River and lower Yellow Creek. White suckers were probably erroneously identified by Pettus (1973 and 1974).

Our Yampa River collections (Table 9) yielded three fish species which had not been reported before our sampling began in 1975 (Table 5). Descriptions of range extensions have not yet been published. The sand shiner was reported from the lower Yampa River by Seethaler et al. (1976) and by some of us (Prewitt et al. 1978) in other sections of the Yampa, but it had not previously been reported from the Yampa River. The presence of larval and early juvenile specimens in our collections indicated a reproducing population of this species in the Yampa River. They were collected from Station Y-4 upstream to Station Y-2b, 3 km below Craig, Colorado. The plains killifish was also reported by Seethaler et al. (1976) and Prewitt et al. (1978). Its presence as far upstream as our Station Y-3 may represent a new distributional limit. Plains killifish were also collected from Lay Creek, Moffat County, Colorado, on 24 June 1976 by BLM Fishery Biologists Jerry Rasmussen and James E. Johnson. The collection site was 1.2 km southwest of the town of Lay, Colorado, on the Lay-Axial road. We sampled this site on 22 July 1977 and collected several specimens. The speckled dace x redside shiner hybrid (tentative identification) has not been previously reported from the Yampa River. About ten specimens, ranging in size from 14 mm to 77 mm, were collected from the Yampa River in 1976 and 1977. In 1978, a Colorado Division of Wildlife sampling team including some of us [illegible] shocked a 135-mm specimen tentatively identified as the same hybrid. Sand shiners appear to be increasing their upstream range due to the sand depositional nature of the Yampa River below Craig. We suspect that killifish and the suspected hybrid between speckled dace and redside shiners may have been present in the Yampa River for some time.

Notably absent from our collections were the rare fishes reported by other authors from the lower Yampa River including bonytail, humpback chub, humpback sucker and hybrids between the latter and flannelmouth sucker. Bonytail are probably extinct or very nearly so. We know of a single confirmed capture in Desolation Canyon on the Green River (Dr. Paul Holden, personal communication) since Holden and Stalnaker (1975a and b) reported that they were rare or scarce in the Green and lower Yampa Rivers. Seethaler et al. (1976) reported finding no bonytail in their 1974-76 Dinosaur National Monument survey and stated that ". . . this species appears close to extinction." Seethaler et al. (1976) collected five humpback chubs on the Yampa River at Echo Park in 1975 and one at Lily Park in 1976; they postulated that humpback chubs were associated with the deeper pools of the upper Colorado River system. Speculation that they might be found in canyon areas which we had not intensively sampled led to limited 1978 efforts to seek out humpback chubs in such areas, but we were not successful. The humpback sucker was considered "common" at two locations in the upper Colorado River by Seethaler et al. (1976), and they cited spawning areas near and 2.5 km above the mouth of the Yampa River. The upstream spawning bar was at the point of greatest upstream penetration of the Yampa River by humpback suckers documented in their study. The humpback sucker is a large-river fish whose spawning migrations may have led it to our study area. Timing of our collection trips may not have coincided with such migrations.

Red shiners, Utah chubs, green sunfish, bluegills, largemouth bass and walleyes did not appear in our collections but were infrequently collected in earlier studies. The confusion regarding red shiners in the papers of Holden and Stalnaker (1975a and b) was mentioned earlier.

The species composition of our fish collections changed with downstream distance in the Yampa River. Collections from the extreme upstream sampling station (Y-1) were distinguished by the absence of carp, sand shiners, Colorado squawfish, plains killifish and ictalurids. No mountain whitefish or rainbow trout were collected at downstream Stations Y-4 and Y-4a, and very few white suckers and their hybrids with native suckers were collected below Station Y-3. Flannelmouth and bluehead suckers made up greater percentages of the electrofishing catch at downstream stations.

The reach of the Yampa River that we sampled supported a more diverse fish fauna than the sampled reach of the White River. Eighteen species and four hybrids were collected from the Yampa; fourteen species and one hybrid were collected from the White River. Six species and three hybrids not found in the White River occurred in our Yampa River collections. Only two species not found in the Yampa were collected from the White River. Differences in the conductivity and velocity of the two rivers were probably responsible for these differences.

Fishes most commonly collected by electrofishing the White River were flannelmouth suckers and mountain whitefish. Speckled dace and flannelmouth suckers were most abundant in our White River seine and dipnet collections. General fish abundance cannot be compared directly with results of most previous White River studies because different reaches were studied or quantitative data were not presented. Fish abundance data which can reasonably be compared with ours were presented by Gulf Oil Corp. and Standard Oil Co. (1975-77) and Baumann and Winget (1975). Speckled dace and flannelmouth suckers were among the most numerous species reported in both of these studies. Red shiners were also listed by Baumann and Winget among the most common fishes in the Utah section of the White River. We noted that the latter species moved upstream to our collection sites during low-flow periods in the White River.

Flannelmouth, white and bluehead suckers dominated our electrofishing collections from the Yampa River. Redside shiners, which were not collected from the White River, dominated 1976 seine and dipnet collections from the Yampa. In 1977, fathead minnows were the most abundant fish in the Yampa River seine and dipnet collections, and redside shiners were second in abundance. Speckled dace and suckers were also commonly collected in both years. Differences in percent composition between 1976 collections by seine and dipnet and those of 1977 were probably the result of differences in discharge levels in the two years. The year 1977 was, as mentioned above, a markedly low-water year. Native fishes appeared to leave shallow waters early and were never dominant elements of seine and dipnet collections.

Baily and Alberti (1952) indicated that speckled dace, flannelmouth suckers and mottled sculpins were most common in their collections. Banks (1964), whose collections were also restricted to the lower Yampa River, collected speckled dace, flannelmouth suckers and chubs (roundtail and bonytail were "lumped") in greatest abundance. Holden and Stalnaker (1975a and b) reported that mountain whitefish, roundtail chub, flannelmouth suckers, bluehead suckers and white suckers were most abundant in their collections from the upper Yampa River. Roundtail chub, speckled dace, redside shiners and flannelmouth suckers were most common in their collections from the lower Yampa. The USDA-REA (1974) study done near Craig, Colorado, resulted in fish collections dominated by speckled dace, mottled sculpins, redside shiners and mountain whitefish. Ecology Consultants, Inc. (1976a-d) collected mottled sculpins, mountain whitefish and white suckers in greatest abundance. There is nothing in these general abundance data to refute the relative abundance figures in our data or to indicate major changes in the most-abundant fish species in the Yampa River in the last quarter of a century. Speckled dace and mottled sculpins appear, however, to have been less common in our collections than in those of some other investigators. Selective fishing gear, lack of good quantitative data and variation in reporting style again limited comparisons which could be made.

Our length-frequency analysis for adult fishes indicated that mountain whitefish and white suckers were most frequently collected at ages 5 and 6; lengths were well-separated in both cases. Flannelmouth and bluehead suckers showed very high frequencies at old ages in the Yampa River with better separation in the small White River sample. The dominant size class of flannelmouth suckers decreased in length with downstream distance.

First-year growth of mountain whitefish from the Yampa River was similar (120 mm) to that reported by Carlander (1969) and Daily (1971) for that species in the Madison River in Wyoming and the Logan River in Utah. Growth in the second year of life was quite different; second year growth was much less in the Yampa (36 mm) than in the Madison and Logan Rivers (96 and 89 mm, respectively). Scott and Crossman (1973) reported considerable variation in lengths at each age in whitefish populations in British Columbia, Alberta, Utah and California. Average lengths of Yampa River whitefish fell within the ranges for ages up to age 6 presented by Northcote (1957). Yampa River whitefish were shorter than the shortest whitefish in Northcote's data at annulus 7; no older whitefish from the Yampa River were aged.

The first annuli of white suckers collected in 1975 could not be detected (Table 26). Our June 1976 progress report, which stated that white suckers were 123 mm long when the first annulus was formed, was in error. Length-frequency analysis of larval and juvenile white suckers collected in 1976 indicated that the average length at age I in late June was 65 mm (Appendix III). When corrected, our age and growth data were similar to those reported for Missouri River white suckers by Carlander (1969).

Age and growth determinations indicated that our Yampa River squawfish grew faster than the Green River fish aged by Vanicek and Kramer (1969). Seethaler (1978) stated that squawfish growth in the Green River was about the same in 1974-76 as in 1964-66. Between 1964 and 1966, Vanicek collected 1469 squawfish. The largest (and oldest) was 610 mm long and 11 years old. Our largest squawfish was 820 mm long and was aged at 11 years. Our fish ranged in age bewteen 6 and 11 years; the majority were between 500 and 640 mm long and 7-8 years old (Table 12).

McAda (1977) reported on the age and growth of flannelmouth suckers from the lower Yampa and Green Rivers. An age and growth table for flannelmouth suckers collected from the Green River in Utah in 1960 was also presented by Carlander (1969). Age data from our length-frequency tables agreed with age class I and II data presented by both Carlander and McAda. However, Carlander and McAda reported total length increments between ages 2 and 3 of 130 and 128 mm, respectively. Our scale and fin-ray data suggest that Yampa River flannelmouth suckers of age classes III-V were as long as those of age classes II and III of McAda and Carlander (Table 24). It is very unlikely that Yampa and White River flannelmouths grew 130 mm between ages 2 and 3 (Appendix III). We captured very few fish in the 130-225 mm size range, probably because of sampling inefficiency. More fish in this size range than were indicated by our sampling were undoubtedly present. Examinations of fin rays and scales from a large sample of fish within the 130-225 mm size range will be needed to more accurately determine flannelmouth sucker age structure. However, our use of scales, fin rays and length-frequency tables provided an indication of their age structure and growth rates. In general, flannelmouths were the oldest suckers collected, attaining a length of 492 mm in 10 years (average growth of 50 mm per year). Bluehead suckers did not appear to grow as large or live quite as long as flannelmouths. They attained lengths of 425 mm at a probable age of 9 years. Their growth rates, however, were similar to those of flannelmouths. The flannelmouth x white sucker hybrids were the largest of all the suckers collected. They reached lengths of 512 mm in 8 years, with an average growth rate greater than that of flannelmouths (64 mm/year). The bluehead x white sucker hybrids grew larger and faster than the blueheads, attaining lengths of 434 mm in 7 years. Growth rates were similar in both the White and Yampa Rivers. Blueheads seemed to attain greater age and size in the White River.

White and Yampa River catostomids generally spawned earlier than cyprinids. Among native fishes, mottled sculpins spawned earliest, in late May. Flannelmouth suckers began their major spawning activities in early June. Bluehead suckers and roundtail chubs spawned in mid to late June.

In the Yampa River, the introduced white sucker entered its peak spawning period later (late June) than the flannelmouth but at about the same time as the bluehead. The spawning season of the introduced redside shiner in the Yampa River began in mid to late June and corresponded closely with that of the native speckled dace. Extensive and opportunistic spawning seasons were noted for the introduced carp, sand shiners and fathead minnows.

Carlander (1969) reported that mountain whitefish fed primarily on aquatic insects. Stream fish were said to take a wider variety of foods, including terrestrial insects, than fish in lakes. This is in general agreement with our data, which showed that mountain whitefish fed primarily on chironomid and simuliid larvae and pupae.

Our analysis of channel catfish food habits was inconsistent with most previous studies of the species (Carlander 1969). *Cladophora* blooms extended from late June through September, and it is unlikely that channel catfish restricted their diets to algae for so many months each year. This is especially true of larger fish, which are known to become piscivorous. Banks (1964) cited *Equisetum* in stomachs of channel catfish from the lower Yampa as evidence of feeding near shore during periods of high water levels.

Dr. Robert Behnke (personal communications) has often expressed the opinion that redside shiners may be competing with and perhaps preying upon young Colorado squawfish. Crossman (1959a and b), Lindsey and Northcote (1963), and Johannes and Larkin (1961) noted that redside shiners feed upon and often compete with other fishes. Scott and Crossman (1973) listed a diverse group of fishes and macroinvertebrates consumed by redside shiners. The food organisms we found in redside shiner stomachs included a relatively-abundant floating adult or terrestrial insect component, indicating some surface-feeding preference. The wide variety of taxa, including insects, other invertebrates, invertebrate eggs and algae indicated both a lack of selection and some degree of opportunism in feeding. As only two shiners we inspected had ingested larval fish, the piscivorous reputation of the species may be upheld mostly by large individuals, which were rarely collected.

Our preliminary analysis of food habits of flannelmouth and bluehead suckers parelleled the results of the limited work of McDonald and Dotson (1960); the greatest proportion of the diet consisted of periphyton and concommitant diatoms and macroinvertebrates. Banks (1964) reported large quantities of filamentous algae and dipteran larvae in flannelmouth suckers (and carp) collected during low-water periods and suggested that they fed over rubble and rock substrates at such times.

Several general conclusions can be drawn from the data on the 18 Colorado squawfish collected during our study. First, our data verified the predatory habits of the squawfish. During evening or nighttime hours, most squawfish were captured near shore in shallow-water areas. Others were captured during early spring runoff in shallow, turbid waters on heavily-overcast days. During clear and partly-cloudy days, squawfish were more frequently collected in deeper mainstream areas.

Squawfish apparently range freely up and down the Yampa and White Rivers. The deep canyon areas on the Yampa probably serve as refugia during periods of low water. However, during runoff, the habitat outside the canyons becomes more desirable than the torrential waters within the canyons. Squawfish were most frequently found outside the canyons at Maybell and Juniper Hot Springs in the spring and early summer. During late summer and early fall, squawfish were found within the canyons or at canyon mouths.

A sizable population of squawfish apparently inhabits the lower 10 km of the White River just above its confluence with the Green River. During 1978, several squawfish were collected there by researchers from the Utah Cooperative Fishery Research Unit, Utah State University (personal communication, Dr. Charles Berry). These fish probably move upstream given the proper flow conditions; this would explain our White River captures in May 1977.

Another explanation of squawfish movement was preferred by Seethaler et al. (1976). They assumed that squawfish entered the Yampa River from the Green in spawning migrations during the summer. They believed that 1) the high water levels of the Yampa in the early summer, in addition to providing potential spawning locations, probably also provide additional habitat and food; 2) when the Yampa River recedes in late summer, habitat and food are greatly reduced, and the fish apparently return to the Green River where conditions are more favorable; and 3) a few squawfish remain upstream in deep pools throughout the year. These assumptions were based on their collections of adult squawfish in the lower Yampa River during July and August after water temperatures had reached 20-21 C. They collected several suspected spent females and one ripe female in the Yampa between the confluence of the Little Snake River and Cross Mountain Canyon in August. Their attempts to capture squawfish in late fall and early spring were unsuccessful.

Given the results of our study and Seethaler's, it is understandable how variable interpretations of migrations could be made. Seethaler's sampling areas were concentrated in the lower Yampa River (Cross Mountain Canyon and below). Most of our effort was devoted to areas above Cross Mountain. Inability to sample the rivers effectively throughout the year under variable conditions of flow and turbidity can also lead to misleading conclusions. It is entirely possible that the habits of squawfish in the lower and upper Yampa differ somewhat. The lower Yampa may be inhabited periodically by squawfish from the Green River, and the upper Yampa may have its own resident population. Although squawfish habitat may be reduced, the food supply for adults and young probably is not greatly reduced in the upper Yampa during late summer.

The question of squawfish reproduction in the Yampa and White Rivers remains a puzzle. We found no evidence of successful reproduction during our study. However, size variation and ageing by scales indicated that there were as many as five age classes of squawfish in the Yampa River. A succession of several successful reproductive years during the late 1960's and early 1970 's was indicated. The question is; where did the reproduction take place?

Our work on macroinvertebrates of the White and Yampa Rivers was unique in that a semi-quantitative approach was taken at permanent collection sites throughout a 2-year period. Several taxa we collected from these streams had previously been collected by others, but no data on longitudinal or seasonal trends were available for comparison with ours. Both streams possessed a diverse and complex aquatic insect community. Mayflies were the predominant insect order in both rivers, and caddisflies and true flies were next in abundance. The two streams were very similar with respect to predominan insect fauna. Insect communities were most dissimilar at upper and lower sampling sites on each river; transition zones existed at middle sites. Insect species diversity was lower for the White River than for the Yampa; White River conditions were less indicative of a "healthy" stream. Relative longitudinal changes in the insect communities of the Yampa River were probably in part due to natural changes in elevation, stream order, substrate, and temperature. Some of the changes were undoubtedly due to point source pollutants, town effluents, and erosion (Pennak 1975, Eddy 1975, Wentz and Steele 1976). The surge in abundance at Sites Y3 and Y4 could have been caused by mild organic enrichment. The substrate at both sites was mixed with organic matter, and the high organic matter levels at Y4 probably accounted for some of the differences in the communities at the two sites. During periods of low flow, a thick algal mat covered the substrate at Y4. The low insect numbers at Y4 were probably due to natural longitudinal changes in the river. Site Y4 was an area of little vegetation and was far downstream from any sizable town; this accounted for the small amount of organic matter in the substrate. The greater amounts of sand and silt at this site contributed to the inadequate habitat for most organisms. Site Y6 was similar to Y5 in substrate type and in community composition and abundance.

All non-insect macroinvertebrate groups on the Yampa and White Rivers were less common than any insect group, and some groups were quite rare. Oligochaete worms may have been undersampled, since they burrow into the sediment. Ames (1977) discussed the use of certain species of mayflies in both streams as indicators of changes in stream substrates resulting from energy development. Oligochaetes showed some potential as indicators of find sediment accumulation.

Comparison of hardness, alkalinity and conductivity values in the White and Yampa Rivers with those typical in large rivers of Colorado's eastern-slope depositional zone showed few differences despite the predominately igneous substrata of the latter zone. This probably bespeaks the load of dissolved organic and inorganic substances contributed to eastern-slope rivers by human activity. The studied sections of the Yampa and White Rivers are as yet largely unimpacted by such disturbances, and their physical and chemical properties reflect their geomorphologic and biotic influences.

Our consideration of fish habitat in combination with data on fishes collected from the White and Yampa Rivers is another unique feature of this report. Banks (1964) and Ecology Consultants, Inc. (1976a-d) generally described habitats in which various Yampa River fishes were collected. We did not attempt to quantitatively describe the habitat for each fish collected, but we can report on certain consistent features which were noted as our study progressed. For those species not showing a clear "preference", habitats were described which denoted the most frequent station of capture. Apparent habitat preferences for adult fishes were as follows. Stream measurements are again expressed in English units to facilitate comparisons with other work.

Bluehead sucker: This species displayed the most obvious habitat preference at Stations Y-2J, Y-3 and Y-4. At these sites, bluehead suckers were captured almost exclusively in or quite near riffles over substrates dominated by cobbles and small boulders. Adult bluehead suckers from Stations Y-1 and Y-2 and from both stations on the White River were distributed throughout the stream. Velocities in the riffle areas at Station Y-4 were predicted (by hydraulic simulation) to range from 1.4 to over 6 feet per second (fps) within a flow range of 100 to 10,000 cfs, while depths fluctuated from 0.5 to 6.4 ft at the thalweg (deepest portion) of the channel.

Flannelmouth sucker: Flannelmouth suckers were collected over a broad range of substrate types, in waters ranging in depth from 0.5 to greater than 8 ft. Generally, however, they preferred shallower water with smaller (sand-cobble) substrates at velocities less than 4 fps. At Station Y-4, the most productive electrofishing was over sand and small cobbles in water about 4 ft deep. Velocities at that stream section were predicted to range from 0.1 to 3.5 fps over the 100-10,000 cfs range. Flannelmouth suckers from the upper Yampa and at both White River stations were widely distributed, showing only a preference for some water velocity.

Roundtail chub: Most roundtail chubs were electrofished from countercurrent or pool areas on the Yampa River and from runs or shallow areas during high water on the White River. No single habitat type was preferred, although the preference for moving water noted in the flannelmouth sucker was also apparent in this species.

Colorado squawfish: Habitat preferences of adult squawfish are summarized in Appendix 1.

White sucker: Present only at the upper Yampa River stations, the white sucker was most frequently captured in those areas also favored by flannelmouth suckers but with a noted preference for lesser velocities. White suckers appeared to associate with large cover objects (e.g. boulders, concrete rip-rap slabs, submerged logs) to a much greater extent than did the native suckers.

Mountain whitefish: At the upper Yampa and White River stations whitefish were most commonly captured in or just below riffles or in pools behind large boulders.

Rainbow trout. Too few rainbow trout were collected to note clear habitat preferences; those captured were most frequently near runs and riffles.

Carp: In both rivers, at all stations, carp frequented areas with little or no velocity. Electrofishing in still or countercurrent pools almost always yielded carp.

Channel catfish: This species occupied habitats ranging from still pools to rather swift riffles. In the lower Yampa River, they were the only species, other than bluehead suckers, noted in the riffles. Most of the large number of catfish collected at Station Y-4 were captured in a shallow, rocky area near the main pool, or in a deep (3-6 ft) run farther downstream. Substrate beneath the run consisted of large boulders with which the fish were closely associated.

Mottled sculpin: Sculpins were seined from very swift waters with large cobble or rubble substrates. The velocities were probably excessive for survival of any of the fishes present, but the large, angular bed elements provided some cover.

Speckled dace: Dace were captured by seining in moving water, pools, backwaters and in quiet water near shore, in almost equal numbers. In July of 1977, at a flow less than 120 cfs at Station W-A, several schools of dace were observed in stranded pools less than 2 in deep in which temperatures exceeded 30 C. The fish were quick to escape and appeared in good condition.

Redside shiner: Disproportionate numbers of redside shiners were seined from backwater areas in our early collections; while there appeared to be a preference for quiet, relatively shallow water, redside shiners were also collected from other habitat types and may have utilized much of the more moderate river area.

Sand shiner: This species was captured most frequently near shore or in backwaters over fine-grained substrates. Small schools were noted in side channel areas at flows which brought water levels just slightly above the in-channel woody vegetation, sedges and rushes. Sand shiners were not normally found among large aggregations of redside shiners.

Red shiner: In the White River, red shiners preferred run and riffle habitats; few were captured in pools and backwaters.

Fathead minnow: Most fathead minnows were seined in backwater pools or quiet areas near the water's edge. Both locations provided shallow, slow waters with fine-grained substrates. Relatively few fatheads were collected from run or riffle areas.

Plains killifish: This species occurred only in Lay Creek, an intermittent Yampa River tributary near Maybell (Station Y-3) and in the Yampa below Y-3. At the time of capture, Lay Creek was not flowing; it existed as a series of standing pools. While water quality parameters were not measured, temperatures were probably high. An abundant growth of green algae and macrophytes was noted.

Many small cyprinids and the larval and early juvenile stages of larger fishes were captured during recessional runoff flows in the flat "bench" areas of the channel. These areas were common to reaches of both rivers. They are a usual feature of fluctuating rivers in which the base flow occupies a small, incised portion of the channel and runoff flows inundate the flat areas extending out to the channel margins. During most of the runoff period, this feature provided large areas of shallow water normally slowed in velocity by emergent vegetation. At Stations Y-3 and Y-4, flows between 1000 and 2000 cfs provided optimal rearing and protection conditions for small fishes; similar conditions were afforded on the White River at 500 to 750 cfs.

Fish species diversity, as estimated by number of species at a station, was highest at Station Y-2. All other Yampa and White River stations yielded fewer species. Habitat diversity, as judged by evaluation of such features as high sinuosity, variable substrates, velocities and depths and shoreline convolusions was lower at Station Y-2 than at any station except perhaps Station Y-3, where species diversity was also quite high. Habitat diversity was highest at Station Y-4, and species diversity was lower there than at the other Yampa River stations. Both White River stations displayed more habitat diversity than did reaches between them which we did not sample. Major portions of the lower White River were featureless runs over sand and small cobble substrates.

At least partial explanations of these anomalies might be 1) habitat diversity may be more difficult to quantify than species diversity, even if detailed cross-sectional measurements are made; 2) increased species diversity may not always be the only result of increased habitat diversity (biomass at the more diverse reaches may be higher); and 3) species diversity may be more influenced by combinations of the effects of physical and biotic characteristics than by physical effects alone.

The high species diversity at Stations Y-2 and Y-3 more likely has resulted from their intermediate longitudinal position on the Yampa River and their consequent roles as aquatic ecotones. The influence of introduced species might also be stronger in such intermediate areas because they are less likely to succeed in the more extreme upstream and downstream conditions. While these hypotheses are supported by the results of our study, more detailed quantification is necessary. We encourage consideration of ecological concepts in further studies on the large rivers of the west; perhaps in this understanding lies our ability to preserve them.

Finally, we wish to encourage continued study of the White and Yampa Rivers as energy development continues in western Colorado. Our study was intended to provide baseline data, and this report must be considered a source of such data with which future work can be compared. Populations of fishes and macroinvertebrates should continue to be monitored, and efforts should be made to maintain the streams in or restore them to conditions as similar to what can be considered "natural" as possible. The Yampa and White Rivers may be the last strongholds that can assure survival of some of the unique fishes of the upper Colorado River system through provision of habitat or amelioration of the effects of other man-induced changes.

## SUMMARY

1. Previous studies of the White and Yampa Rivers were reviewed.

2. Fishes were studied from July 1975 through September 1978 on the Yampa River between the Lily Park Pool area near Cross Mountain Canyon and Hayden, Colorado, and on the White River between Spring Creek and Rio Blanco Lake.

3. Macroinvertebrates were studied from Cross Mountain to Steamboat Springs on the Yampa River and from Rangely to Meeker, Colorado, on the White River from July 1975 through October 1976.

4. Physical and chemical conditions were determined at fish-sampling stations from July 1975 through August 1978, and detailed measurements of stream dimensions were made at two sites on each river in 1976 and 1977.

5. Electrofishing and collection by seines, dipnets, gill nets and plankton nets resulted in collection of 18 fish species and four hybrid fishes from the Yampa River. Six species and three hybrids not found in the White River were collected from the Yampa. Fourteen fish species and one hybrid were collected from the White River; of these, two species were not found in the Yampa.

6. Flannelmouth, white and bluehead suckers, redside shiners, fathead minnows and speckled dace were most commonly collected from the Yampa River. Flannelmouth suckers, mountain whitefish and speckled dace were most abundant in White River fish collections.

7. Sand shiners, plains killifish and speckled dace x redside shiner hybrids, which had not been reported before 1975, were collected from the Yampa River.

8. Eighteen Colorado squawfish were collected from the two streams, but bonytail, humback chub, humpback suckers and humpback x flannelmouth sucker hybrids reported in earlier studies of the Yampa River were not encountered.

9. The species composition of Yampa River fish collections changed with downstream distance. Salmonids were not collected at the downstream station, and carp, sand shiners, Colorado squawfish, plains killifish and ictalurids were not collected at the upstream station. White suckers and their hybrids with native suckers were rare and native suckers were more abundant at the downstream station.

10. Growth of mountain whitefish and flannelmouth suckers was relatively slow after the first 1 and 3 years of life, respectively. Growth of white suckers was similar to that reported in other streams, and Colorado squawfish in the Yampa River grew faster than squawfish collected 1964-76 in the Green River.

11. Flannelmouth and bluehead suckers decreased in size with downstream distance in the Yampa River.

12. Catostomids generally spawned earlier than cyprinids in the two streams. Peak spawning seasons for most species extended over at least one month. Spawning times were correlated with temperature and discharge data.

13. Mountain whitefish fed primarily on chironomid and simuliid larvae and pupae, and channel catfish and flannelmouth and bluehead suckers

primarily on algae. Redside shiners fed primarily on true flies, seemed somewhat opportunistic in feeding and were not piscivorous.

14. One hundred insect taxa were collected from the Yampa River and 77 were collected from the White.

15. Mayflies were the predominant aquatic macroinvertebrates in both streams, and caddisflies and true flies were next in abundance. The predominant macroinvertebrates in the two rivers were very similar.

16. Total mean aquatic insect abundance was greatest at the Middle Yampa River station and at the upstream station on the White River. Aquatic insect abundance was greatest in the fall or early winter of 1975 and 1976 on the Yampa River. A seasonal trend in insect abundance on the White River was not supported by statistical tests.

17. Shannon-Weaver diversity values for aquatic insects of the Yampa River were higher than for the White River. Moderate pollution of the White River was indicated.

18. Hardness, alkalinity and conductivity in the Yampa and White Rivers were similar to those of large rivers on Colorado's eastern-slope depositional zone. Chemical conditions were generally compatible with good fish production.

19. Analysis of habitat in conjunction with fish-collection data allowed speculation on the habitat "preferences" of the fishes most commonly collected from the two streams.

20. Further studies of the fauna of the White and Yampa Rivers with emphasis on basic ecological concepts was encouraged.

LITERATURE CITED


Allen, R. K. and G. F. Edmunds. 1959. A revision of the genus Ephemerella (Ephemeroptera: Ephemerellidae) I. Subgenus Timpanoga. Canadian Ent. 91:51-58.

Allen, R. K. and G. F. Edmunds. 1962. A revision of the genus Ephemerella (Ephemeroptera: Ephemerellidae) V. Subgenus Drunella in North America. Misc. Publ. Ent. Soc. Amer. 3:145-179.

Allen, R. K. and G. F. Edmunds. 1965. A revision of the genus Ephemerella (Ephemeroptera: Ephemerellidae) VIII. Subgenus Ephemerella in North America. Misc. Publ. Ent. Soc. Amer. 4:244-282.

Ames, E. L. 1977. Aquatic insects of two western slope rivers, Colorado. M. S. Thesis, Colorado State Univ., Ft. Collins. 95 pp.

Andreasen, J. K. and J. R. Barnes. 1975. Reproductive life history of Catostomus ardens and C. discobolus in the Weber River, Utah. Copeia 1975 (4):645-648.

Andrews, A. K. and S. A. Flickinger. 1973. Spawning requirements of the fathead minnow. Proc. Ann. Meeting S.E. Assoc. Game and Fish Commissioners 27:759-766.

Ashland Oil, Inc. and Shell Oil Co. 1975-1976. Oil shale tract C-b summary reports 1-8. Reports submitted to Area Oil Shale Supervisor, U.S. Geol. Surv., Grand Junction, Colorado.

Athearn, F. J. 1977. An isolated empire: a history of Northwest Colorado. 2nd ed. Colorado State Office, Bur. Land Manage., Denver. 139 pp.

Bailey, J. E. 1952. The life history and ecology of the sculpin, Cottus bairdi punctulatus in southwestern Montana. Copeia 1952 (4):243-255.

Bailey, R. M. et al (ed.). 1970. A list of common and scientific names of fishes from the United States and Canada. 3rd ed. Amer. Fish. Soc. Spec. Publ. 6. 150 pp.

Baily, C. and R. Alberti. 196[illegible]. Lower Yampa River and tributaries study. Fed. Aid Proj. F-3-R-1. Trout stream studies: 154-180. Colorado Game and Fish Dept., Denver.

Banks, J. L. 196[illegible]. Fish species distribution in Dinosaur National Monument during 1961-62. M. S. Thesis, Colorado State Univ., Ft. Collins. 96 pp.

Bauer, D. P., T. D. Steele, and R. D. Anderson. 197[illegible]. Analyses of waste-load assimilative capacity of the Yampa River, Steamboat Springs to Hayden, Routt County, Colorado. U.S. Geol. Surv. Water Resources Invest. 77-119. [illegible] pp.

Baumann, R. W. and R. N. Winget. 1975. Aquatic macroinvertebrates, water quality and fish population characterization of the White River, Uintah Co., Utah. Utah Studies for Wildlife on Energy Areas, Utah Div. Wildlife Resources. 54 pp.

Baxter, G. T. and J. R. Simon. 1970. Wyoming fishes (revised). Wyoming Game and Fish Dept. Bull. 4. 168 pp.

Beckman, W. C. 1952. Guide to the fishes of Colorado. Univ. Colorado Mus., Boulder. 111 pp.

Behnke, R. J. 1973a. Rare and endangered species report: the bonytail chub. Colorado Coop. Fish. Unit, Colorado State Univ., Ft. Collins. 7 pp.

Behnke, R. J. 1973b. Rare and endangered species report: The Colorado squawfish. Colorado Coop Fish. Unit, Colorado State Univ., Ft. Collins. 10 pp.

Behnke, R. J. 1973c. Rare and endangered species report: the humpback chub. Colorado Coop. Fish. Unit, Colorado State Univ., Ft. Collins. 5 pp.

Behnke, R. J. 1973d. Rare and endangered species report: the razorback sucker. Colorado Coop. Fish. Unit, Colorado State Univ., Ft. Collins. 7 pp.

Berner, L. 1959. A tabular summary of the biology of North American mayfly nymphs (Ephemeroptera). Bull. Florida State Mus. 4:1-57.

Bishop, A. B. and D. B. Porcella. 1976. Physical and ecological aspects of the upper Colorado River basin in relation to energy development and environmental problems. Utah Water Research Laboratory, Utah State Univ., Logan. 32 pp.

Bovee, K. D. and R. Milhous. 1978. Hydraulic simulation in instream flow studies; theory and techniques. Instream Flow Info. Paper 5. Coop. Instream Flow Service Group, Ft. Collins, Colorado. 130 pp.

Bragensky, R. Y. 1960. Early development of the carp. pp. 129-49. In C. G. Krevanoveski (ed.). Works on the early development of bony fishes. Stud. A. N. Stenertsova Inst. Anim. Morphol. Soviet Acad. Sci. 28.

Burkhard, W. T. 1966. Stream fishery studies; statewide stream surveys. Fed Aid Rep. F-26-R-3, Job 1. Colorado Dept. Game, Fish, Parks, Denver. 166 pp.

Burks, B. D. 1953. The mayflies or Ephemeroptera of Illinois. Bull. Illinois Natur. Hist. Surv. 26:1-216.

Carlander, K. D. 1969. Handbook of freshwater fishery biology. Vol. 1, 3rd ed. Iowa State Univ. Press, Ames. 752 pp.

Colorado River Fishes Recovery Team. 1978. Colorado squawfish recovery plan. U. S. Fish Wildl. Serv., Washington, D.C. 30 pp. + appendices.

Colorado Water Conservation Board and USDA. 1966. Water and related land resources, White River Basin in Colorado. Economic Research Serv., Forest Serv., Soil Conservation Serv., Denver, Colorado. 92 pp.

Colorado Water Conservation Board and USDA. 1969. Water and related land resources, Yampa River Basin, Colorado and Wyoming. Economic Research Serv., Forest Serv., Soil Conservation Serv., Denver, Colorado. 164 pp.

Crawford, A. B. and D. F. Peterson (eds.). 1974. Environmental management of the Colorado River basin. Utah State Univ. Press, Logan. 313 pp.

Crawford, D. R. 1923. The significance of food supply in the larval development of fishes. Ecology 4(2):147-153.

Crawford, D. R. 1925. Field characters identifying young salmonid fishes in fresh waters of Washington. Univ. Washington Publ. Fish. 1(2):64-76

Crossman, E. J. 1959a. Distribution and movements of a predator, the rainbow trout, and its prey, the redside shiner, in Paul Lake, B.C. J. Fish. Res. Bd. Canada 16(3):247-267.

Crossman, E. J. 1959b. A predator-prey interaction in freshwater fish. J. Fish. Res. Bd. Canada 16(3)269-281.

Daily, M. K. 1971. The mountain whitefish: a literature review. Univ. Idaho Forest, Wildlife and Range Experiment Station, Paper 8. 18 pp.

Dobie, J. R., O. L. Meehean, S. F. Snieszko and G. N. Washburn. 1956. Raising bait fishes. U. S. Dept. Int., Fish Wildl. Serv. Circ. 35. 123 pp.

Douglas, P. A. 1952. Notes on the spawning of the humpback sucker, Xyrauchen texanus (Abbott). Calif. Fish Game 38(2):149-155.

Ecology Consultants, Inc. 1976a. Yampa Project Interim Phase D: Ecological investigations near Craig Station Site, Moffat County, Colorado. Tech. Rept. 240. Ecology Consultants, Inc., Ft. Collins, Colorado. 59 pp.

Ecology Consultants, Inc. 1976b. Yampa Project Interim Phase D: Ecological investigations near Crag Station Site, Moffat County, Colorado. Tech. Rept. 300. Ecology Consultants, Inc., Ft. Collins, Colorado. 64 pp.

Ecology Consultants, Inc. 1976c. Yampa Project Interim Phase D: Ecological investigations near Hayden Station, Routt County, Colorado. Tech. Rept. 241. Ecology Consultants, Inc., Ft. Collins, Colorado. 40 pp.

Ecology Consultants, Inc. 1976d. Yampa Project Interim Phase D: Ecological investigations near Hayden Station, Routt County, Colorado. Tech. Rept. 301. Ecology Consultants, Inc., Ft. Collins, Colorado. 43 pp.

Eddy, R. M. 1975. The effect of point-source discharges on the diversity of benthic macroinvertebrates of the Yampa River, Steamboat Springs to Hayden, Colorado. Tech. Inves. Branch, Surveillance and Analysis Division, EPA Rep. SA/TIB-30. Environ. Protect. Agency, Denver, Colorado. 20 pp.

Eddy, S. 1957. How to know the freshwater fishes. W. C. Brown Co., Dubuque, Iowa. 253 pp.

Edmondson, W. T. (ed.). 1959. Fresh-water biology. John Wiley and Sons, Inc., New York. 1248 pp.

Environmental Protection Agency. 1977. Report of baseline water quality investigations on the White River in western Colorado. EPA-90812-77-001. Region VIII, Denver, Colorado.

Everhart, W. H. and B. E. May. 1973. Effects of chemical variations in aquatic environments: Vol. I. Biota and chemistry of Piceance Creek. U. S. EPA Ecol. Res. Ser. EPA-R3-73-011a.

Everhart, W. H. and W. R. Seaman. 1971. Fishes of Colorado. Colorado Game, Fish, Parks Div., Denver. 75 pp.

Feast, C. N. 1938. A preliminary study of the proposed whitefish transplanting in western Colorado streams. U. S. Forest Serv., Ft. Collins, Colorado.

Fish, M. P. 1932. Contributions to the early life histories of sixty-two species of fishes from Lake Erie and its tributary waters. U. S. Bur. Fish. Bull. 47(10):293-398.

Fuiman, L. A. 1978. Descriptions and comparisons of Northeastern catostomid fish larvae. M. S. Thesis, Cornell Univ., Ithaca, New York. 110 pp.

Fuiman, L. A. and J. J. Loos. 1977. Identifying characters of the early development of the daces Rhinichthys atratulus and R. cataractae (Osteichthyes: Cyprinidae). Proc. Acad. Nat. Sci. Philadelphia 129(2):23-32.

Goettl, J. P. and J. W. Edde. 1978. Fishes of the Piceance Basin, Colorado, prior to oil shale processing. Environmental Res. Lab., U. S. Environ. Protect. Agency, Duluth, Minnesota. Draft seen.

Gulf Oil Corp. and Standard Oil Co. (Indiana). 1975-1977. Progress reports 1-9 - summary on tract C-a oil shale development. Reports submitted to area oil shale supervisor, U. S. Geol. Surv., Grand Junction, Colorado.

Hagen, H. K. and J. L. Banks. 1963. Ecological and limnological studies of the Green River in Dinosaur National Monument. Contract No. 14 - 10-0232-686 between U. S. Dept. Interior, Nat. Park Service, and Colorado State Univ., Ft. Collins. 31 pp.

Hess, R. H. and W. D. Klein. 1947. Report on trend area creel census, 1945-1946. Colorado Dept. Game Fish, Denver. 8 pp.

Hill, R. 1964. Stream fishery studies: White River survey. Fed. Aid Proj. F-26-R-1, Job No. 2. Colorado Dept. Game, Fish, Parks, Denver. 72 pp.

Hill, R. R. 1965. White River survey. Fed Aid Rep. F-26-R-2, Job 2. Colorado Dept. Game, Fish, Parks, Fish. Res. Div., Denver. 54 pp.

Hill, R. R. and W. T. Burkhard. 1967. White River Survey. Fed. Aid Rep. F-26-R-3, Job. 2. Colorado Dept. Game, Fish, Parks, Fish. Res. Div., Denver. 29 pp.

Hogue, Jr., J. J., R. Wallus, and L. K. Kay. 1976. Preliminary guide to the identification of larval fishes in the Tennessee River. Tenn. Valley Auth., Tech. Note B19. 66 pp.

Holden, P. B. 1973. Distribution, abundance and life history of the fishes of the upper Colorado River basin. Ph.D. Dissertation, Utah State Univ., Logan. 59 pp.

Holden, P. B. and C. B. Stalnaker. 1970. Systematic studies of the cyprinid genus Gila, in the upper Colorado River basin. Copeia 1970 (3):409-420.

Holden, P. B. and C. B. Stalnaker. 1975a. Distribution and abundance of mainstream fishes of the middle and upper Colorado River basins, 1967-73. Trans. Amer. Fish. Soc. 104(2):217-231.

Holden, P. B. and C. B. Stalnaker. 1975b. Distribution of fishes in the Dolores and Yampa River systems of the upper Colorado basin. Southwest. Natur. 19(4):403-412.

Howard, R. W. 1978. John Wesley Powell - conquerer of the Colorado. Conservationist 33(3):17-19, 48.

Hubbs, C. L. and L. C. Hubbs. 1947. Natural hybrids between two species of catostomid fishes. Pap. Mich. Acad. Sci. 31(1945):147-167.

Hynes, H. B. N. 1970. The ecology of running waters. Univ. Toronto Press, Ontario. 555 pp.

[illegible], W. V., C. H. Hembree, D. A. Phoenix and G. L. Oakwood. 1964. Water resources of the upper Colorado River basin -- Basic data. U. S. Geol. Surv. Prof. Paper 442. 1036 pp.

[illegible], W. V., C. H. Hembree and G. L. Oakland. 1965. Water resources of the upper Colorado River basin. Technical Report. U. S. Geol. Surv. Prof. Paper 441. [illegible] pp.

[illegible] 1961. Experimental ecology of the feeding of fishes. Yale Univ. Press, New Haven, Connecticut. [illegible] pp.

[illegible] 1966. The mayflies of Idaho (Ephemeroptera). Parts I-V. [illegible], Univ. of Utah, Salt Lake City. 36[illegible] pp.

Johannes, R. E. and P. A. Larkin. 1961. Competition for food between redside shiner (Richardsonius balteatus) and rainbow trout (Salmo gairdneri) in two British Columbia lakes. J. Fish. Res. Bd. Canada 18(2):203-220.

Johnson, J. E. 1976. Status of endangered and threatened fish species in Colorado. U. S. Dept. Interior, Bur. Land Manage. Tech. Note. Form 1220-5. 21 pp. + 2 appendices.

Jordan, D. S. and B. W. Evermann. 1896. The fishes of North and Middle America. Bull. U. S. National Mus., Part 1, 47:1-1240.

Kidd, G. T. 1975. Preliminary report on endangered and threatened endemic warmwater species of fish in western Colorado waters. Fed. Aid Proj. F-30-R-11. Colorado Div. Wildlife, Denver. 15 pp.

Klein, W. D. 1952. Voluntary returns from plants of tagged trout 1946 through 1951. Colorado Game Fish Dept., Fish Manage. Div., Denver. 92 pp.

Klein, W. D. 1957. A partial census of the whitefish and trout population in the Yampa and White Rivers and their tributaries. Spec. Purpose Rep. 47. Colorado Dept. Game Fish, Denver. 18 pp.

Koster, W. J. 1957. Guide to the fishes of New Mexico. Univ. of New Mexico Press, Albuquerque. 116 pp.

Langlois, D. 1977. Status of razorback sucker and bonytail chub in western Colorado. Colo. Div. Wildlife, Denver. 10 pp.

Lemons, D. G. 1954. A field survey of western Colorado streams and lakes. Colorado Dept. Game Fish, Denver. 29 pp.

Lemons, D. G. 1955. Channel cat study. Proj. No. 121. Colorado Dept. Game, Fish, Parks, Denver. 9 pp.

Lindsey, C. C. and T. G. Northcote. 1963. Life history of redside shiners, Richardsonius balteatus, with particular reference to movements in and out of Sixteen-mile Lake streams. J. Fish. Res. Bd. Canada 20(4):1001-1030.

Lippson, A. J. and R. L. Moran. 1974. Manual for identification of early developmental stages of fishes of the Potomac River estuary. Power Plant Siting Program, Maryland Dept. Natural Resources, Baltimore. 282 pp.

Long, W. L. and W. W. Ballard. 1976. Normal embryonic stages of the white sucker, Catostomus commersoni. Copeia 1976 (2):342-351.

Lynch, T. M. 1957. Growth data on fourteen fish species collected from the warm water regions of Colorado. Spec. Purpose Rept. 48. Colorado Dept. Game Fish, Denver. 16 pp.

Lynch, T. M. and D. G. Lemons. 1956. The age, growth and weight relationships of channel catfish (Ictalurus punctatus) collected from Colorado waters. Colorado Dept. Game Fish, Denver. 13 pp.

Mansueti, A. J. and J. D. Hardy. 1967. Development of fishes of the Chesapeake Bay region, an atlas of egg, larval and juvenile stages. Natural Resources Institute, Univ. Maryland, Baltimore. 202 pp.

Mason, W. T. 1973. An introduction to the identification of chironomid larvae. U. S. Environ. Protect. Agency, Cincinnati, Ohio. 90 pp.

May, B. E. 1970. Biota and chemistry of Piceance Creek. M. S. Thesis, Colorado State Univ., Ft. Collins. 152 pp.

May, E. B. and C. R. Gasaway. 1967. A preliminary key to the identification of larval fishes of Oklahoma, with particular reference to Canton Reservoir, including a selected bibliography. Oklahoma Fish. Res. Lab., Norman. 32 pp. + appendices.

McAda, C. W. 1977. Aspects of the life history of three catostomids native to the upper Colorado River basin. M. S. Thesis, Utah State Univ., Logan. 104 pp.

McDonald, D. B. and P. A. Dotson. 1960. Fishery investigations of the Glen Canyon and Flaming Gorge impoundment areas. Utah State Dept. Fish Game Info. Bull. 60-3.

McKean, W. T. and W. T. Burkhard. 1978. Fish and wildlife analysis for the Yellow Jacket Project. Prepared for U. S. Bur. Reclamation by the Colorado Div. Wildlife, Denver. 543 pp.

Miller, R. R. 1946. The need for ichthyological surveys of the major rivers of western North America. Science 104(2710):517-519.

Miller, R. R. 1959. Origins and affinities of the freshwater fish fauna of western North America. pp. 187-222. In C. L. Hubbs (ed.) Zoogeography. Amer. Assoc. Adv. Sci. 41:1-509.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game Fish Dept., Phoenix. 293 pp.

Moore, G. A. 1968. Fishes. pp. 21-165. In Blair, W. F., A. P. Blair, P. Brad Korb, F. R. Cagle, and G. A. Moore. Vertebrates of the United States. McGraw-Hill Book Co., New York. 616 pp.

Morgan, N. C. and H. J. Egglishaw. 1965. A survey of the bottom fauna of streams in the Scottish Highlands. Part I. Composition of the fauna. Hydrobiol. 25:181-211.

Northcote, T. G. 1957. A review of the life history and management of the mountain whitefish. Fish Manage. Div., British Columbia. 6 pp.

Lynch, T. M. and D. G. Lemons. 1956. The age, growth and weight relationships of channel catfish (Ictalurus punctatus) collected from Colorado waters. Colorado Dept. Game Fish, Denver. 13 pp.

Mansueti, A. J. and J. D. Hardy. 1967. Development of fishes of the Chesapeake Bay region, an atlas of egg, larval and juvenile stages. Natural Resources Institute, Univ. Maryland, Baltimore. 202 pp.

Mason, W. T. 1973. An introduction to the identification of chironomid larvae. U. S. Environ. Protect. Agency, Cincinnati, Ohio. 90 pp.

May, B. E. 1970. Biota and chemistry of Piceance Creek. M. S. Thesis, Colorado State Univ., Ft. Collins. 152 pp.

May, E. B. and C. R. Gasaway. 1967. A preliminary key to the identification of larval fishes of Oklahoma, with particular reference to Canton Reservoir, including a selected bibliography. Oklahoma Fish. Res. Lab., Norman. 32 pp. + appendices.

McAda, C. W. 1977. Aspects of the life history of three catostomids native to the upper Colorado River basin. M. S. Thesis, Utah State Univ., Logan. 104 pp.

McDonald, D. B. and P. A. Dotson. 1960. Fishery investigations of the Glen Canyon and Flaming Gorge impoundment areas. Utah State Dept. Fish Game Info. Bull. 60-3.

McKean, W. T. and W. T. Burkhard. 1978. Fish and wildlife analysis for the Yellow Jacket Project. Prepared for U. S. Bur. Reclamation by the Colorado Div. Wildlife, Denver. 543 pp.

Miller, R. R. 1946. The need for ichthyological surveys of the major rivers of western North America. Science 104(2710):517-519.

Miller, R. R. 1959. Origins and affinities of the freshwater fish fauna of western North America. pp. 187-222. In C. L. Hubbs (ed.) Zoogeography. Amer. Assoc. Adv. Sci. 41:1-509.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game Fish Dept., Phoenix. 293 pp.

Moore, G. A. 1968. Fishes. pp. 21-165. In Blair, W. F., A. P. Blair, P. Brad Korb, F. R. Cagle, and G. A. Moore. Vertebrates of the United States. McGraw-Hill Book Co., New York. 616 pp.

Morgan, N. C. and H. J. Egglishaw. 1965. A survey of the bottom fauna of streams in the Scottish Highlands. Part I. Composition of the fauna. Hydrobiol. 25:181-211.

Northcote, T. G. 1957. A review of the life history and management of the mountain whitefish. Fish Manage. Div., British Columbia. 6 pp.

Olsen, P. F. 1973. Wildlife resources of the Utah Oil Shale Area. Utah Wildlife Resources Div. Publ. 74-2. 147 pp.

Pennak, R. W. 1953. Fresh-water invertebrates of the United States. Ronald Press Co., New York. 769 pp.

Pennak, R. W. 1974. Limnological status of streams, Piceance Creek Basin, Rio Blanco and Garfield Counties, Colorado. ROSS-23, prepared for the State of Colorado. Thorne Ecological Institute, Boulder, Colorado.

Pennak, R. W. 1975. Aquatic inventory and framework of the Yampa River from Steamboat Springs. Wastewater Management Report, 201 Facilities Plan, Vol. 1, Wright-McLaughlin Engineers, Denver, Colorado. 24 pp.

Pettus, D. 1973. Cold-blooded vertebrates of the Piceance Creek Basin, Rio Blanco and Garfield Counties, Colorado. ROSS-10, prepared for the State of Colorado. Thorne Ecological Institute, Boulder, Colorado.

Pettus, D. 1974. Inventory and impact analysis of fishes, Piceance Creek Basin, Rio Blanco and Garfield Counties, Colorado. ROSS-25, prepared for the State of Colorado. Thorne Ecological Institute, Boulder, Colorado.

Pflieger, W. L. 1975. The fishes of Missouri. Missouri Dept. of Conservation, Jefferson City. 343 pp.

Prewitt, C. G. 1977. Catostomid fishes of the White and Yampa Rivers Colorado. M. S. Thesis, Colorado State Univ., Ft. Collins. 122 pp.

Prewitt, C. G., E. J. Wick and D. E. Snyder. 1978. Population and habitat monitoring program for the endangered humpback chub (Gila cypha) and Colorado squawfish (Ptychocheilus lucius), progress report for 1977. Report to Colorado Div. Wildlife, Denver. 53 pp. + appendices.

Saksena, V. P. 1962. The post-hatching stages of the red shiner, Notropis lutrensis. Copeia 1962 (3):539-544.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Canada Bull. 184. Ottawa. 966 pp.

Seethaler, K. 1978. Life history and ecology of the Colorado squawfish (Ptychocheilus lucius) in the upper Colorado River basin. M. S. Thesis, Utah State Univ., Logan. 156 pp.

Seethaler, K. H., C. W. McAda, and R. S. Wydoski. 1976. Endangered and threatened fish in the Yampa and Green Rivers of Dinosaur National Monument. Utah Coop. Fish. Res. Unit, Utah State Univ., Logan. 22 pp.

Sigler, W. F. and R. R. Miller. 1963. Fishes of Utah. Utah State Dept. Fish Game, Salt Lake City. 203 pp.

Simon, J. R. and R. C. Brown. 1943. Observations on the spawning of the sculpin, Cottus semiscaber. Copeia 1943 (2):41-42.

Smallwood, W. M. and M. L. Smallwood. 1931. The development of the carp, Cyprinus carpio. I. The larval life of the carp, with special reference to the development of the intestinal canal. J. Morphol. Physiology 52(1):217-231.

Smith, G. R. 1966. Distribution and evolution of the North American catostomid fishes of the sub-genus Pantosteus, genus Catostomus. Misc. Publ. Mus. Zool. Univ. Michigan 129:1-132.

Smith, G. R. 1973. Analysis of several hybrid cyprinid fishes from western North America. Copeia 1973 (3):395-410.

Snyder, D. E. 1976a. Terminologies for intervals of larval fish development. pp. 42-60. In Boreman, J. (ed.). Great Lakes fish egg and larvae identification: Proceedings of a workshop. U. S. Fish. Wildl. Serv. National Power Plant Team, Ann Arbor, Michigan.

Snyder. D. E. 1976b. Report of working group II, identification tools, what's available and what could be developed? pp. 88-96. In Boreman, J. (ed.). Great Lakes fish egg and larvae identification: Proceedings of a workshop. U. S. Fish. Wildl. Serv. National Power Plant Team, Ann Arbor, Michigan.

Snyder, D. E., M. B. M. Snyder and S. C. Douglas. 1977. Identification of golden shiner, Notemigonus crysoleucas, spotfin shiner, Notropis spilopterus, and fathead minnow, Pimephales promelas, larvae. J. Fish. Res. Bd. Canada 34:1397-1409.

Spence, L. E. 1975. Guidelines for using Water Surface Profile program to determine instream flow needs for aquatic life. Montana Fish Game Dept. Envir. Info. Div., Prelim. Draft. 22 pp.

Steele, T. D. 1975. Coal-resource development alternatives, residual management, and impacts on the water resources of the Yampa River Basin, Colorado and Wyoming. Paper presented at: Symposium on Water Resources and Fossil Fuel Production, International Water Resources Association, Dusseldorf, Germany. 14 pp.

Steele, T. D., D. A. Wentz, and J. W. Warner. 1978. Hydrologic reconnaissance of the Yampa River during low flow, Dinosaur National Monument, Northwestern Colorado. U. S. Geol. Surv. Open File Report 78-226. 10 pp.

Suttkus, R. D. and G. H. Clemmer. 1977. The humpback chub, Gila cypha, in the Grand Canyon area of the Colorado River. Occas. Pap. Tulane Univ. Mus. Nat. Hist. 1. 30 pp.

Summerfelt, R. C. and C. O. Minckley. 1969. Aspects of the life history of the sand shiner, Notropis stramineus (Cope), in the Smoky Hill River, Kansas. Trans. Amer. Fish Soc. 98(3):444-453.

Taber, C. A. 1969. The distribution and identification of larval fishes in the Buncombe Creek Arm of Lake Texoma with observations on spawning habits and relative abundance. Ph.D. Thesis, Univ. Oklahoma, Norman. 120 pp.

Tesch, F. W. 1971. Age and growth. pp. 98-130. In Ricker, W. E. (ed.), Methods for assessment of fish production in fresh waters. Blackwell Scientific Publications, Oxford, England. 348 pp.

U. S. Department of Agriculture, Rural Electrification Administration. 1974. Yampa Project final environmental analysis. USDA-REA-ES(ADM)-72-2-F. USDA & REA, Washington, D.C.

U. S. Department of the Interior. 1976. Final environmental statement. Northwest Colorado coal. U. S. Dept. of Interior, Washington, D.C.

Usinger, R. L. (ed.). 1956. Aquatic insects of California. Univ. California Press, Berkeley. 508 pp.

Utah Wildlife Resources Division. 1977. White River environmental impact statement. Utah Wildlife Resources Div., Salt Lake City. 69 pp.

Vanicek, C. D. and R. H. Kramer. 1969. Life history of the Colorado squawfish, *Ptychocheilus lucius*, and the Colorado chub, *Gila robusta*, in the Green River in Dinosaur National Monument, 1964-1966. Trans. Amer. Fish. Soc. 98(2):193-208.

Weber, C. I. (ed.). 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. U. S. Environ. Protect. Agency, Cincinnati, Ohio. 295 pp.

Weber, D. T. 1966. Correlation and evaluation of stream survey data. Job Comp. Rep., Fed Aid Proj. F-26-R-4, Job 7. Colorado Dept. Game, Fish, Parks, Denver. 19 pp.

Weisel, G. F. and H. W. Newman. 1951. Breeding habits, development and early life history of *Richardsonius balteatus*, a northwestern minnow. Copeia 1951 (3):187-194.

Wentz, D. A. and T. D. Steele. 1976. Surface-water quality in the Yampa River basin, Colorado and Wyoming--an area of accelerated coal development. Presented at Conf. on Water for Energy Development, Engineering Foundation, Pacific Grove, California, Dec. 5-10, 1976. 28 pp.

Wilbur, C. G. 1973. Water quality in the Piceance Creek Basin, Rio Blanco and Garfield Counties, Colorado. ROSS-11, prepared for the State of Colorado. Thorne Ecological Institute, Boulder, Colorado.

Wilbur, C. G. 1974. Evaluation of the oil shale industry upon water quality, Piceance Creek Basin, Rio Blanco and Garfield Counties, Colorado. ROSS-26, prepared for the State of Colorado. Thorne Ecological Institute, Boulder, Colorado.

Wilhm, J. L. and T. C. Dorris. 1968. Biological parameters for water quality criteria. Bioscience 18:477-481.

Williams, T. and B. C. Bedford. 1973. The use of otoliths for age determination. pp. 114-123. In Bagenal, T. B. (ed.). Ageing of fish. Unwin Brothers, Ltd., Surrey, England. 234 pp.

Wilson, L. J. 1973. White River fishery investigations. Utah State Wildlife Resources Div. Memorandum, Nov. 26, 1973. 6 pp.

Winn, H. E. and R. R. Miller. 1954. Native postlarval fishes of the lower Colorado River Basin, with a key to their identification. Calif. Fish Game 40(3):273-285.

Witchers, W. F. 1975. The use of fin spines in age determinations of carp. Dept. of Zoology and Physiology, Univ. Wyoming, Laramie. Mimeo.

APPENDIX I.

Description of endangered fish collections from the White and Yampa Rivers, 1975-1978.

The only threatened or endangered fish species collected during our study was the Colorado squawfish, Ptychocheilus lucius. On 7 August 1975 we collected our first squawfish at Station Y-3 on the Yampa River near Maybell. On 27 August 1975 three squawfish were collected at the west base of Cross Mountain Canyon (Station Y-4a). All four squawfish captured in August 1975 were collected in overnight gill net sets.

The fish were captured near the surface, within 10 m of shore, over sand and silt substrates. In 1975, electrofishing was ineffective in capturing squawfish. However, a large squawfish (estimated at 10-12 lbs) was "turned" at Station Y-4, and a smaller squawfish (approximately 500 mm long) was turned at the mouth of Cross Mountain Canyon.

Concurrent to our work on the Yampa River, Carl Seethaler of Utah State University was conducting a life history study on the Colorado squawfish. Because of Seethaler's intensive sampling and the possibility of needless mortality to squawfish by our overlapping efforts, we discontinued gill netting at our lower Yampa River stations. By the summer of 1976, we discontinued gill-net sampling entirely.

No adult squawfish were collected in 1976, nor were any larval or young-of-the-year squawfish collected in spite of intensive sampling by seine and dipnet.

On 22 April 1977, at Station Y-3, Maybell, we captured our first squawfish by electrofishing. This fish was captured at midstream in rapidly-flowing water about 0.5 m deep. The time of capture was 1530 hrs, and the weather was clear and warm. On 27 May 1977, two squawfish were shocked in the White River at Station W-A, 2 m from shore in a small eddy behind submerged brush. Water depth at the point of capture was approximately 0.5 m. However, a cross section of the area (C.S. 318, Appendix VIIc) revealed a steep drop-off just beyond the point of capture. Water velocity was less than 1 ft/sec. A second squawfish was shocked nearby in a midstream pool. Water depth at that location was 1.2 m and velocity was less than 1 ft/sec. A detailed cross section was made at this site (C.S. 238, Appendix VIIc). These fish were captured at about 1000 hrs on a cool, cloudy day. Water temperature was 11 C.

On 27 June 1977 we collected a squawfish by electrofishing at Juniper Hot Springs (Staton Y-2J). The fish was collected near midstream in water 0.9 m deep. Average water-column velocity was 1.3 ft/sec, and water temperature was 26 C. Examination of the fish revealed slight reddish pigmentation in the pectoral, dorsal and caudal fins. No tuberculation was evident. Time of capture was 1630 hrs, and the skies were partly cloudy.

On 21 April 1978 another squawfish was captured at Juniper Hot Springs. On the same day, at Maybell, three more squawfish were captured, and another was turned and positively identified. Two fish were shocked in shallow water over gravel bars. Two others were located near the downstream tips of islands, and another was located just below an irrigation return flow in a side channel.

These squawfish were apparently feeding and/or resting during an early migration; we noticed many small fish darting in front of the boat as we electrofished these areas. The weather was cold and cloudy with periods of heavy snow. Spring runoff had begun, and the water was turbid. The water temperature was 7 C.

On 11 October 1978, we shocked two squawfish at the west base of Cross Mountain Canyon (Station Y-4). These fish were captured within 10 m of shore at dusk.

On 12 October 1978, four squawfish were shocked approximately 0.3 km inside the upper end of Juniper Springs Canyon. This section of the upper canyon was slightly constricted, and the water velocity increased slightly at the point of capture. The entire upper half of the canyon was pooled behind a large boulder field mid-way through the canyon. All the squawfish were captured close together in water that varied in depth from 0.5 to 1.5 m over sand, cobble and boulder substrate.

APPENDIX II.

Numbers of fishes collected by gear and station for each collecting trip, 1976 and 1977.

Appendix IIa. Numbers of fishes collected from the Yampa River by electrofishing, 10 July 1975 through 17 September 1975.

| Species | July 10-13 Station | | | | | July 18-21 Station | | | | | August 5-7 Station | | | | | August 26 Station | | | September 17 Station | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 3 | 4a | 4 | 1 | 2 | 3 | 4 |
| *Prosopium williamsoni* | | | | | | | | | | | 4 | | | | | | | | 24 | 7 | | |
| *Salmo gairdneri* | | 1 | | | | | | 1 | | | | | | | | | | | 3 | | | |
| *Salmo trutta* | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Cyprinus carpio* | | 2 | | | | | | 2 | | | | | 2 | 4 | | 3 | 1 | | | | 1 | 6 |
| *Gila robusta* | | 1 | | | | | 2 | | | | | 1 | 1 | | | 3 | | 1 | | | | 2 |
| *Ptychocheilus lucius* | | | | | | | | | | | | | 1 | | | | 4 | | | | | |
| *Pimephales promelas* | | | | | | | | | | | | | | | | | | | | | X | X |
| *Richardsonius balteatus* | | | | | | | | | | | | | | | | X | X | X | X | X | X | X |
| *Rhynichthys osculus* | | | | | | | | | | | | | | | | 2 | X | X | X | X | X | X |
| *Semotilus atromatulatus* | | | | | | | | | | | | | | | | | | X | | | | |
| *Catostomus commersoni* | | 3 | | 1 | | 7 | 12 | 1 | | | 6 | 11 | 3 | | | | | | 6 | 17 | 5 | |
| *Catostomus (Pantosteus) discobolus* | | | | | | 1 | 1 | 3 | 2 | | 4 | 4 | 2 | 7 | | 2 | 6 | 18 | | 4 | 1 | 16 |
| *Catostomus latipinnis* | | 6 | | 3 | | | 4 | 16 | 25 | | 6 | 2 | 18 | 7 | | 7 | 6 | 5 | 5 | 4 | 13 | 26 |
| *Ictalurus punctatus* | | | | | | | | | 2 | | | | | | | 3 | 9 | 1 | | | | 27 |
| *Ictalurus melas* | | | | | | | | | | | | | | | | | | | | | | |
| *Cottus bairdi* | | | | | | | | | | | 3 | 4 | X | X | | X | X | X | 1 | | | |
| Hybrids | | | | | | | | | | | | | | | | | | | | | | |
| *Catostomus commersoni* x *C. latipinnis* | | | | | | | | | | | | | | | | | | | 1 | 2 | 3• | |
| *C. commersoni* x *C. discobolus* | | | | | | 2 | 1 | | | | 4 | | | | | | | | 2 | 5 | | |

Note: "X" in place of number = present but not ennumerated.

Appendix IIb. Number of fishes collected by seine and boat electrofishing from the Yampa River during 19-21 May 1976.

| Gear | Electrofishing | | | | | Seine | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Station | 1 | 2 | 3 | 4 | Total | 1 | 2 | 3 | 4 | Total |
| *Prosopium williamsoni* | 8 | 4 | - | - | 12 | - | 11 | 2 | - | 13 |
| *Cyprinus carpio* | - | - | 1[b] | 3 | 4 | - | - | - | - | - |
| *Gila robusta* | - | - | - | 2 | 2 | - | - | 27 | 2 | 29 |
| *Notropis stramineus* | - | - | - | - | - | - | - | 15 | 1 | 16 |
| *Pimephales promelas* | - | - | - | - | - | 8 | 49 | 33 | - | 90 |
| *Rhinichthys osculus* | - | - | - | - | - | 21 | 2 | 179 | 68 | 270 |
| *Richardsonius balteatus* | - | - | - | - | - | 73 | 58 | 1009 | 58 | 1198 |
| Unidentified Cyprinidae[a] | - | - | - | - | - | - | 2 | 1 | - | 3 |
| *Catostomus commersoni* | 2 | 27 | - | - | 29 | 8 | 13 | 42 | 1 | 64 |
| *Catostomus discobolus* | - | - | - | 1 | 1 | - | 1 | 241 | 1 | 243 |
| *Catostomus latipinnis* | - | - | 3[b] | 18 | 21 | - | 1 | 27 | 3 | 31 |
| *C. discobolus* x *commersoni* | - | - | - | - | - | - | - | 3[c] | - | 3 |
| *C. latipinnis* x *commersoni* | - | 3 | - | 1 | 4 | - | - | - | - | - |
| *Cottus bairdi* | - | - | - | - | - | - | - | - | 13 | 13 |
| Total | 10 | 34 | 4 | 25 | 73 | 110 | 137 | 1579 | 147 | 1973 |

a. Either a previously undescribed species or a hybrid, possibly *Rhinichthys osculus* x *Richardsonius balteatus*.
b. Released unprocessed with several smaller cyprinids.
c. Identity not certain.

Appendix IIc. Number of fishes collected by seine, dipnet, and boat electrofishing from the Yampa River during 1-3 June 1976.

| Gear / Station | Electrofishing 1 | 2 | 3 | 4 | Total | Seine and dip net 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 5 | 4[c] | 1[c] | - | 10 | 1 | 10 | 2 | - | 13 |
| *Salmo gairdneri* | 1 | - | - | - | 1 | - | - | - | - | - |
| *Cyprinus carpio* | - | - | 1[c] | 6 | 7 | - | - | - | - | - |
| *Gila robusta* | - | 1 | 2 | 4 | 7 | - | - | 20 | 7 | 27 |
| *Notropis stramineus* | - | - | - | - | - | - | - | 10 | 3 | 13 |
| *Pimephales promelas* | - | - | - | - | - | 2 | 3 | 38 | - | 43 |
| *Rhinichthys osculus* | - | - | - | - | - | 12 | 8 | 174 | 60 | 254 |
| *Richardsonius balteatus* | - | - | - | - | - | 5 | 36 | 294 | 36 | 371 |
| Unidentified Cyprinidae[b] | - | - | - | - | - | - | - | 1 | - | 1 |
| *Catostomus commersoni* | 10 | 3 | 4 | 2 | 19 | - | 1 | 15 | 1 | 17 |
| *Catostomus discobolus* | - | - | 1 | 1 | 2 | - | - | 38 | 2 | 40 |
| *Catostomus latipinnis* | - | 1 | 12 | 13 | 26 | - | - | 7 | 1 | 8 |
| *C. discobolus* x *commersoni* | - | 4 | - | - | 4 | - | - | - | - | - |
| *C. latipinnis* x *commersoni* | - | - | 1 | - | 1 | - | - | - | - | - |
| *Ictalurus punctatus* | - | - | - | 1 | 1 | - | - | - | - | - |
| *Cottus bairdi* | - | - | - | - | - | - | 1 | - | 3 | 4 |
| Total | 16 | 13 | 22 | 27 | 78 | 20 | 59 | 599 | 113 | 791 |

a. Includes 8 *R. osculus*, 4 *R. balteatus*, and 8 *C. discobolus* taken in experimental overnight minnow trap sets.
b. Either a previously undescribed species or a hybrid, possibly *Rhinichthys osculus* x *Richardsonius balteatus*.
c. One specimen collected by seine but processed and released with electrofishing specimens.

Appendix IId. Number of fishes collected by seine and boat electrofishing from the Yampa River during 22-24 June 1976.

| Gear / Station | Electrofishing[a] 1 | 2 | 3 | Total | Seine and Dipnet 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 5 | 1 | - | 6 | 43 | 23 | - | - | 66 |
| *Salmo gairdneri* | - | 1 | - | 1 | - | - | - | - | - |
| *Cyprinus carpio* | - | - | 1 | 1 | - | - | - | - | - |
| *Gila robusta* | - | - | 1 | 1 | - | - | 4 | 5 | 9 |
| *Notropis stramineus* | - | - | - | - | - | - | 3 | 6 | 9 |
| *Pimephales promelas* | - | - | - | - | 2 | 13 | 3 | - | 18 |
| *Rhinichthys osculus* | - | - | - | - | 7 | 1 | 47 | 18 | 73 |
| *Richardsonius balteatus* | - | - | - | - | 37 | 11 | 59 | 48 | 155 |
| *Catostomus commersoni* | 12 | 18 | 1 | 31 | - | - | 6 | 1 | 7 |
| *Catostomus discobolus* | 4 | - | 1 | 5 | - | - | 20 | 2 | 22 |
| *Catostomus latipinnis* | 2 | 5 | 17 | 24 | - | 47 | 811 | 90 | 948 |
| *C. discobolus* x *commersoni* | - | - | - | - | - | - | - | 1 | 1 |
| *C. latipinnis* x *commersoni* | - | 5 | 2 | 7 | - | - | - | - | - |
| Unidentified Catostomidae | 5[b] | 1[b] | - | 6[c] | - | 17 | 26 | 7 | 50 |
| *Fundulus kansae* | - | - | - | - | - | - | 1 | - | 1 |
| *Cottus bairdi* | - | - | - | - | 6 | - | - | 14 | 20 |
| Total | 28 | 31 | 23 | 82 | 95 | 112 | 980 | 192 | 1379 |

a. Collection at station 4 not made due to very high turbidity.
b. All released without positive identification.
c. At least three were hybrids.

Appendix IIe. Numbers of fishes collected by dipnet, seine and boat electrofishing from the Yampa River during 15-17 July 1976.

| Gear Station | Electrofishing 1 | 2 | 3 | 4 | Total | Seine and Dipnet 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 9 | 1 | - | - | 10 | 1 | 2 | - | - | 3 |
| *Salmo gairdneri* | - | 3 | - | - | 3 | - | - | - | - | - |
| *Cyprinus carpio* | - | - | 1 | 4 | 5 | - | - | 10 | - | 10 |
| *Gila robusta* | - | - | 1 | 5 | 6 | - | 7[b] | 29 | 4 | 40 |
| *Notropis stramineus* | - | - | - | - | - | - | - | 3 | 5 | 8 |
| *Pimephales promelas* | - | - | - | - | - | 5 | 29 | 4 | 2 | 40 |
| *Rhinichthys osculus* | - | - | - | - | - | 12 | 43 | 59 | 174 | 288 |
| *Richardsonius balteatus* | - | - | - | - | - | 83 | 151 | 108 | 55 | 407 |
| Unidentified Cyprinidae[a] | - | - | - | - | - | 1 | - | - | - | 1 |
| *Catostomus commersoni* | 17 | 4 | - | - | 21 | 131[c] | 277[c] | 21[c] | - | 429 |
| *Catostomus discobolus* | 4 | 4 | 6 | 15 | 29 | 94 | 136[c] | 178[c] | 166 | 574 |
| *Catostomus latipinnis* | 2 | 1 | 7 | 6 | 16 | 66 | 48 | 118 | 48 | 280 |
| *C. discobolus* x *commersoni* | 5 | 6 | - | - | 11 | - | - | - | - | - |
| *C. latipinnis* x *commersoni* | - | 1 | 1 | - | 2 | - | - | 1 | - | 1 |
| Unidentified Catostomidae | - | - | - | - | - | - | 4[d] | - | - | 4 |
| *Ictalurus punctatus* | - | - | - | 3 | 3 | - | - | - | - | - |
| *Cottus bairdi* | 1 | - | - | - | 1 | 8 | 7 | - | 1 | 16 |
| Total | 38 | 20 | 16 | 33 | 107 | 401 | 714 | 531 | 455 | 2101 |

a. Either a previously undescribed species or a hybrid, possibly *Rhinichthys osculus* x *Richardsonius balteatus*.
b. Identity of smaller metalarvae and mesolarvae not certain.
c. Unidentified protolarvae and recently transformed mesolarvae.

Appendix IIf. Number of fishes collected by dipnet, seine and boat electrofishing from the Yampa River during 4-7 August 1976.

| Gear / Station | Electrofishing[a] 2 | 3 | 4 | Total | Seine and Dipnet 1 | 2 | 3 | 4 | 4a[b] | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 3 | - | - | 3 | 1 | 1 | - | - | - | 2 |
| *Salmo gairdneri* | 5 | - | - | 5 | - | - | - | - | - | - |
| *Cyprinus carpio* | - | - | 2 | 2 | - | - | 87 | 1 | - | 88 |
| *Gila robusta* | - | 1 | - | 1 | 154 | 28 | 192 | 34 | - | 408 |
| *Notropis stramineus* | - | - | - | - | - | - | 156 | 8 | - | 164 |
| *Pimephales promelas* | - | - | - | - | 48 | 17 | 5 | 1 | 5 | 76 |
| *Rhinichthys osculus* | - | - | - | - | 78 | 117 | 509 | 231 | 1 | 936 |
| *Richardsonius balteatus* | - | - | - | - | 189 | 112 | 239 | 110 | 2 | 652 |
| *Semotilus atromaculatus* | - | - | - | - | - | - | - | - | 1 | 1 |
| *R. osculus* x *R. balteatus* | - | - | - | - | 1 | - | 1 | - | - | 2 |
| *Catostomus commersoni* | 2 | - | - | 2 | 74 | 39[c] | 12[c] | 2 | 2 | 129 |
| *Catostomus discobolus* | 2 | 11 | 21 | 34 | 73 | 109[c] | 37[c] | 128[c] | - | 347 |
| *Catostomus latipinnis* | 3 | 3 | 7 | 13 | 15 | 15 | 65 | 26 | 1 | 122 |
| *C. discobolus* x *commersoni* | 2 | 1 | - | 3 | - | - | - | - | - | - |
| *C. discobolus* x *latipinnis* | - | 2 | - | 2 | - | - | - | - | - | - |
| *C. latipinnis* x *commersoni* | 3 | 1 | - | 4 | - | - | 1 | - | - | 1 |
| Unidentified catostomids | - | - | - | - | 74 | - | - | - | - | 74 |
| *Ictalurus punctatus* | - | - | 3 | 3 | - | - | - | - | - | - |
| *Cottus bairdi* | - | - | - | - | 2 | 3 | - | 3 | - | 8 |
| Total | 20 | 19 | 33 | 72 | 709 | 441 | 1304 | 544 | 12 | 3010 |

a. Station 1 modofied by local bulldozer preventing use of electrofishing boat.
b. Includes 1 *S. atromaculatus* and 2 *P. promelas* provided by Karl Seethaler of Utah State Univ., collected at site about 18 hours prior to our collection.
c. Identity of smaller metalarvae and mesolarvae not certain.

Appendix IIg. Number of fishes collected by seine and dip net from the Yampa River during 16-19 August 1976.[a]

| Station | 1 | 2 | 2a | 2b | 2c | 2d | 2e | 2f | 3 | 4 | 4a | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| *Cyprinus carpio* | - | - | - | 1 | - | - | 1 | - | 61 | - | - | 63 |
| *Gila robusta* | 28 | 7 | 2 | 6 | 25 | 1 | 12 | 1 | 112 | 31 | 34 | 259 |
| *Notropis stramineus* | - | - | - | 1 | - | - | 1 | - | 20 | 1 | 6 | 29 |
| *Pimephales promelas* | 49 | 439 | 289 | 101 | 1 | 11 | 1 | - | 5 | - | - | 896 |
| *Rhinichthys osculus* | 174 | 99 | - | 9 | 18 | 9 | 61 | 12 | 124 | 49 | 12 | 567 |
| *Richardsonius balteatus* | 192 | 117 | 20 | 73 | - | 115 | 20 | - | 117 | 50 | 23 | 727 |
| Unidentified cyprinids[c] | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 |
| *Catostomus commersoni* | 22 | 10 | - | 16 | 47 | 17 | 9 | - | 4 | - | 2 | 127 |
| *Catostomus discobolus* | 168 | 28 | - | 63 | 7 | 12 | 19 | 6 | 174 | 18[b] | 1 | 496 |
| *Catostomus latipinnis* | 5 | 9 | - | 19 | 3 | 28 | 13 | - | 40 | 7 | 23 | 147 |
| Unidentified catostomids | 28 | 44 | - | 110 | 6 | 7 | - | - | - | - | - | 195 |
| *Cottus bairdi* | 2 | - | - | 2 | 2 | - | 1 | 1 | - | 1 | - | 9 |
| Total | 669 | 754 | 311 | 402 | 109 | 200 | 138 | 20 | 657 | 157 | 101 | 3518 |

a. Portion of river between Craig and Juniper Springs Canyon (2a - 2f) sampled while traveling river by canoe; no electrofishing this trip.
b. Identity of smaller metalarvae and mesolarvae not certain.
c. Suspected *Rhinichthys osculus* and *Richardsonius balteatus*.

Appendix IIh. Number of fishes collected by seine, dipnet, and boat electrofishing from the Yampa River, 9-10 October 1976.

| Gear / Station | Electrofishing[a] | Sein and Dip Net | | | | |
|---|---|---|---|---|---|---|
| | 4 | 1 | 2 | 3 | 4 | Total |
| *Cyprinus carpio* | - | - | - | 4 | - | 4 |
| *Gila robusta* | 1 | 2 | 6 | - | 77 | 85 |
| *Notropis stramineus* | - | - | - | 198 | 20 | 218 |
| *Pimephales promelas* | - | 39 | 94 | 15 | 3 | 151 |
| *Rhinichthys osculus* | - | 12 | 13 | 8 | 12 | 45 |
| *Richardsonius balteatus* | - | 145 | 303 | 107 | 471 | 1026 |
| *Catostomus commersoni* | - | 16 | 6 | - | - | 22 |
| *Catostomus discobolus* | 1 | 7 | 7 | 5 | 15 | 34 |
| *Catostomus latipinnis* | 15 | 5 | - | 2 | 2 | 9 |
| *Ictalurus punctatus* | 1 | - | - | - | - | - |
| *Cottus bairdi* | 0 | 2 | 2 | - | 3 | 7 |
| Total | 18 | 228 | 431 | 339 | 603 | 1601 |

a. Low waters and limited time restricted electrofishing to Station 4.

Appendix IIi. Number of fishes collected by seine and dipnet from Yampa River in 1977.

| Collection Date | May 25-26 | | | | | June 27-28 | | | | | July 27-29 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Y1 | Y2J | Y3 | Y4 | Total | Y1 | Y2J | Y3 | Y4 | Total | Y1 | Y2J | Y3 | Y4 | Y4a | Total |
| *Prosopium williamsoni* | 25 | - | - | - | 25 | 1 | - | - | - | 1 | 1 | - | - | - | - | 1 |
| *Cyprinus carpio* | - | - | 1 | - | 1 | - | - | - | 2 | 2 | - | 4 | 16 | 1 | - | 21 |
| *Gila robusta* | - | 6 | 24 | 6 | 36 | - | 11 | 1 | - | 12 | 123 | 36 | 80 | 16 | 15 | 270 |
| *Notropis stramineus* | - | - | 4 | 48 | 52 | - | - | 17 | 2 | 19 | - | - | 99 | - | 10 | 109 |
| *Pimephales promelas* | 19 | 22 | 8 | 1 | 50 | 5 | 3 | 1 | - | 9 | 309 | 394 | 555 | 19 | 17 | 1294 |
| *Rhinichthys osculus* | 23 | 21 | 11 | 13 | 68 | 6 | 3 | 6 | 64 | 79 | 37 | 217 | 118 | 63 | 61 | 496 |
| *Richardsonius balteatus* | 62 | 187 | 88 | 24 | 361 | 3 | 4 | 8 | 1 | 16 | 185 | 8 | 41 | 470 | 2 | 706 |
| *Catostomus commersoni* | 15 | 13 | 13 | - | 41 | 329 | 2 | 10 | 5 | 346 | 96 | 11 | - | 2 | 6 | 115 |
| *Catostomus discobolus* | 8 | 13 | 4 | 1 | 26 | 42 | 65 | 66 | 81 | 254 | 61 | 134 | 23 | 46 | 8 | 272 |
| *Catostomus latipinnis* | 1 | 4 | 3 | - | 8 | 28 | 152 | 246 | 139 | 565 | 10 | 172 | 59 | 60 | 43 | 344 |
| *R. osculus* x *R. balteatus* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| *Cottus bairdi* | - | 2 | 1 | 2 | 5 | 1 | 1 | 1 | 1 | 4 | 2 | - | 2 | 3 | 2 | 9 |
| *C. discobolus* | - | - | - | - | - | - | - | 6 | - | 6 | - | - | 1 | - | - | 1 |
| *Ictalurus melas* | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 2 |
| *C. latipinnis* x *commersoni* | - | - | - | - | - | - | - | - | - | - | 1 | - | 5 | - | 1 | 7 |
| Total | 153 | 268 | 157 | 95 | 673 | 415 | 241 | 362 | 295 | 1313 | 826 | 978 | 999 | 681 | 164 | 3648 |

Appendix IIj. Numbers of fishes collected from the White River by electrofishing, 12 July 1975 through 19 September 1975.

| Collection Date / Site | July 12 Station B | July 12 Station A | July 19 Station B | July 19 Station A | August 7 Station B | August 26 Station B | September 19 Station B |
|---|---|---|---|---|---|---|---|
| *Gila robusta* | 3 | 5 | 1 | 1 | 3 | 3 | 1 |
| *Rhinichthys osculus* | | | | | X | X | X |
| *Richardsonius balteatus* | | | | | | X | X |
| *Semotilus atromaculatus* | | | | 1 | | | 1 |
| *Catostomus (Pantosteus) discobolus* | | 1 | | | 1 | | 3 |
| *Catostomus latipinnis* | 7 | 11 | 2 | 19 | 15 | 2 | 7 |
| *Ictalurus punctatus* | | | | | 2 | | 1 |
| *Ictalurus melas* | | | | | 1 | | |

Note: X = present but not ennumerated

Appendix IIk. Number of fishes collected by seine, dipnet and boat electrofishing from the White River during 19-21 May and 1-3 June 1976.

| Collection Date | 19-21 May | | | | | | 1-3 June | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gear | Electrofishing | | | Seine and Dip Net | | | Electrofishing | | | Seine and Dip Net | | |
| Station | A | B | Total | A | B | Total | A | B | Total | A | B | Total |
| *Prosopium williamsoni* | 2 | - | 2 | 70 | - | 70 | 4 | - | 4 | 12 | - | 12 |
| *Cyprinus carpio* | - | - | - | - | - | - | 1 | - | 1 | - | - | - |
| *Gila robusta* | 5 | - | 5 | - | - | - | - | 1 | 1 | 1 | - | 1 |
| *Notropis lutrensis* | - | - | - | - | 1 | 1 | - | - | - | - | - | - |
| *Pimephales promelas* | - | - | - | 18 | 10 | 28 | - | - | - | 16 | - | 16 |
| *Rhinichthys osculus* | - | - | - | 167 | 307 | 474 | - | -[a] | - | 47 | 31 | 78 |
| *Catostomus discobolus* | 3 | 1 | 4 | 22 | 17 | 39 | 2 | - | 2 | 25 | 2 | 27 |
| *Catostomus latipinnis* | 8 | 3 | 11 | 6 | 15 | 21 | 11 | 12 | 23 | 1 | 1 | 2 |
| *Catostomus platyrhynchus* | - | - | - | 1 | - | 1 | - | - | - | - | - | - |
| *C. discobolus* x *latipinnis* | - | - | - | - | - | - | 1 | - | 1 | - | - | - |
| *Cottus bairdi* | - | - | - | 1 | - | 1 | - | -[b] | - | 1 | - | 1 |
| Total | 18 | 4 | 22 | 285 | 350 | 635 | 19 | 13 | 32 | 103 | 34 | 137 |

a. One specimen collected, but released unprocessed.
b. One specimen immobilized but not netted.

Appendix III. Number of fishes collected by dipnet, seine and boat electrofishing from the White River during 22-24 June and 15-17 July 1976.[a]

| Collection Date | 22-24 June | | | | 15-17 July | | |
|---|---|---|---|---|---|---|---|
| Gear | Electrofishing | Seine and Dip Net | | | Seine and Dip Net | | |
| Station | A | A | B | Total | A | B | Total |
| *Prosopium williamsoni* | 5 | 5 | - | 5 | - | - | - |
| *Cyprinus carpio* | 2 | - | - | - | 1 | 7 | 8 |
| *Gila robusta* | - | - | - | - | 22 | 10 | 32 |
| *Pimephales promelas* | - | 5 | - | 5 | 1 | - | 1 |
| *Rhinichthys osculus* | - | 12 | 21 | 33 | 18 | 132 | 150 |
| *Catostomus discobolus* | 1 | 7 | 2 | 9 | 213[b] | 16 | 229 |
| *Catostomus latipinnis* | 29 | 13 | 277 | 290 | 171 | 74 | 245 |
| *Cottus bairdi* | - | - | 28 | 28 | 5 | 3 | 8 |
| Total | 37 | 42 | 328 | 370 | 431 | 242 | 673 |

a. Station B during 22-24 June and Stations A and B during 15-17 July were not sampled by boat electrofishing due to low water levels, high conductivity, and/or high turbidity.
b. Possibility of confusion with early young of *C. platyrhynchus*.

Appendix IIm. Number of fishes collected by dipnet, seine and electrofishing, hand-held electrodes, from the White River during 4-6 August and 26 August 1976[a].

| Collection Date<br>Gear<br>Station | 4-6 August<br>Seine and Dip Net<br>A | <br><br>B | <br><br>Total | 26 August<br>Electrofishing<br>A | <br><br>W-73 | <br><br>Total |
|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 1 | - | 1 | 4[c] | - | 4 |
| *Cyprinus carpio* | 3 | - | 3 | - | - | - |
| *Gila robusta* | 55 | 22 | 77 | - | - | - |
| *Pimephales promelas* | 13 | 5 | 18 | - | 1[d] | 1 |
| *Rhinichthys osculus* | 93 | 123 | 216 | 3[d] | 9[d] | 12 |
| *Catostomus discobolus* | 174[b] | 49 | 223 | 2 | 5[e] | 7 |
| *Catostomus latipinnis* | 37 | 25 | 62 | 6[f] | 2 | 8 |
| *C. discobolus* x *latipinnis* | - | - | - | 1 | - | 1 |
| *Ictalurus melas* | - | - | - | 1 | - | 1 |
| *Cottus bairdi* | 7 | 8 | 15 | - | - | - |
| Total | 383 | 232 | 615 | 17 | 17 | 34 |

a. No boat electrofishing was possible due to low water levels, high conductivity and/or high turbidity. The 26 August trip was a special electrofishing trip with Colorado Division of Wildlife Personnel using hand-held electrodes at Station A and a site of interest to the DOW, W-73.
b. Possibility of confusion with early young of *C. platyrhynchus*.
c. Includes three specimens preserved and processed with seine material.
d. Specimens preserved and processed with seine material.
e. Includes one specimen preserved and processed with seine material.
f. Includes two specimens preserved and processed with seine material.

Appendix IIn. Numbers of fish collected by seine and dipnet from the White River in 1977.

| Collection Date<br>Site | May 26-27<br>WA | <br>WB | <br>Total | June 28<br>WA | <br>WB | <br>Total | July 31-August 2<br>WA | <br>WB | <br>Total |
|---|---|---|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | - | - | - | - | - | - | 1 | - | 1 |
| *Cyprinus carpio* | - | - | - | - | - | - | 20 | 3 | 23 |
| *Gila robusta* | - | - | - | - | 2 | 2 | 68 | 22 | 90 |
| *Pimephales promelas* | 5 | - | 5 | - | 3 | 3 | 11 | 5 | 16 |
| *Notropis lutrensis* | - | - | - | - | 5 | 5 | 3 | 9 | 12 |
| *Rhinichthys osculus* | 3 | 11 | 14 | 17 | 77 | 94 | 137 | 44 | 181 |
| *Catostomus discobolus* | 4 | 2 | 6 | 41 | 10 | 51 | 18 | 8 | 26 |
| *Catostomus latipinnis* | 1 | - | 1 | 31 | 136 | 167 | 27 | 12 | 39 |
| *Cottus bairdi* | 5 | 1 | 6 | - | - | - | - | 1 | 1 |
| Total | 18 | 14 | 32 | 89 | 233 | 322 | 285 | 104 | 389 |

## APPENDIX III.

Length-frequency distribution of fishes collected by seine and dipnet in the Yampa and White Rivers, 1976 and 1977.

# APPENDIX III.

Length-frequency distribution of fishes collected by seine and dipnet in the Yampa and White Rivers, 1976 and 1977.

Appendix IIIa. Length frequency distribution of <u>Prosopium williamsoni</u> collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | | | | |
| 10-14 | | | | | | | | |
| 15-19 | | | | | | | | |
| 20-24 | 5 | 7 | 3 | | | | | |
| 25-29 | 6 | 3 | 16 | | | | | |
| 30-34 | | 2 | 25 | | | | | |
| 35-39 | | 1 | 16 | | | | | |
| 40-44 | | | 5 | 1 | | | | |
| 45-49 | | | 1 | | | | | |
| 50-54 | | | | | | | | |
| 55-59 | | | | 1 | | | | |
| 60-64 | | | | 1 | 1 | | | |
| 65-69 | | | | | | | | |
| 70-74 | | | | | | | | |
| 75-79 | | | | | | 1 | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | | | | | | | |
| 95-99 | | | | | | | | |
| 100- | | | | | | | | |

Appendix IIIb. Length frequency distribution of *Prosopium williamsoni* collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | |
| 10-14 | | | |
| 15-19 | 2 | | |
| 20-24 | 12 | | |
| 25-29 | 10 | | |
| 30-34 | 1 | | |
| 35-39 | | | |
| 40-44 | | | |
| 45-49 | | 1 | |
| 50-54 | | | |
| 55-59 | | | |
| 60-64 | | | |
| 65-69 | | | |
| 70-74 | | | |
| 75-79 | | | |
| 80-84 | | | |
| 85-89 | | | |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | |

Appendix IIIc. Length frequency distribution of *Prosopium williamsoni* collected by seine and dipnet in the White River in 1976.

| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | | | |
| 10-14 | | | | | | |
| 15-19 | | | | | | |
| 20-24 | | | | | | |
| 25-29 | 4 | 3 | | | | |
| 30-34 | 29 | 4 | | | | |
| 35-39 | 35 | 3 | | | | |
| 40-44 | 2 | 5 | 1 | | | |
| 45-49 | | | 1 | | | |
| 50-54 | | | 1 | | | |
| 55-59 | | | 1 | | | |
| 60-64 | | | 1 | | | |
| 65-69 | | | | | | |
| 70-74 | | | | | | |
| 75-79 | | | | | | |
| 80-84 | | | | | | |
| 85-89 | | | | | | 1 |
| 90-94 | | | | | | 1 |
| 95-99 | | | | | | |
| 100- | | | | | | 1 |

Appendix IIId. Length frequency distribution of *Cyprinus carpio* collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | 6 | 2 | | | |
| 10-14 | | | | | 7 | | | |
| 15-19 | | | | | 30 | 2 | | |
| 20-24 | | | | | 22 | 2 | | |
| 25-29 | | | | | 14 | 10 | | |
| 30-34 | | | | | 8 | 18 | | |
| 35-39 | | | | | | 13 | | 1 |
| 40-44 | | | | | 1 | 14 | | 1 |
| 45-49 | | | | 3 | | 2 | | |
| 50-54 | | | | 1 | | 1 | | 1 |
| 55-59 | | | | | | | | |
| 60-64 | | | | | | | | 1 |
| 65-69 | | | | | 1 | | | |
| 70-74 | | | | | 1 | | | |
| 75-79 | | | | | | 1 | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | | | | | | | |
| 95-99 | | | | | | | | |

Appendix IIIe. Length frequency distribution of *Cyprinus carpio* collected by seine and dipnet from the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | 2 | 1 |
| 10-14 | | | |
| 15-19 | | | 15 |
| 20-24 | | | 10 |
| 25-29 | | | 5 |
| 30-34 | | | 1 |
| 35-39 | | | 2 |
| 40-44 | 1 | | |
| 45-49 | | | |
| 50-54 | | | |
| 55-59 | | | |
| 60-64 | | | |
| 65-69 | | | |
| 70-74 | | | |
| 75-79 | | | |
| 80-84 | | | |
| 85-89 | | | |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | |

Appendix IIIf. Length frequency distribution of *Cyprinus carpio* collected by seine and dipnet in the White River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | 3 | | | | |
| 10-14 | | | | | | | | |
| 15-19 | | | | | | | | |
| 20-24 | | | | 1 | | | | |
| 25-29 | | | | | | | | |
| 30-34 | | | | | 1 | | | |
| 35-39 | | | | | 2 | | | |
| 40-44 | | | | | | | | |
| 45-49 | | | | | | | | |
| 50-54 | | | | | | | | |
| 55-59 | | | | | | | | |
| 60-64 | | | | | | | | |
| 65-69 | | | | | | | | |
| 70-74 | | | | | | | | |
| 75-79 | | | | | | | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | | | | | | | |
| 95-99 | | | | | | | | |

Appendix IIIg. Length frequency distribution of *Cyprinus carpio* collected by seine and dipnet from the White River in 1977.

| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | | | |
| 10-14 | | | | |
| 15-19 | | | | |
| 20-24 | | | | |
| 25-29 | | | | |
| 30-34 | | | | |
| 35-39 | | | | 1 |
| 40-44 | | | | 1 |
| 45-49 | | | | |
| 50-54 | | | | 1 |
| 55-59 | | | | |
| 60-64 | | | | |
| 65-69 | | | | |
| 70-74 | | | | |
| 75-79 | | | | |
| 80-84 | | | | |
| 85-89 | | | | |
| 90-94 | | | | |
| 95-99 | | | | |
| 100- | | | | |

Appendix IIIh. Length frequency distribution of *Gila robusta* collected by seine and dipnet from the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | | | | |
| 10-14 | | | | 18 | 78 | 1 | | |
| 15-19 | | | | 17 | 117 | 10 | | |
| 20-24 | | | | | 80 | 30 | | |
| 25-29 | | | | | 68 | 56 | | 1 |
| 30-34 | 3 | | | | 41 | 56 | | 6 |
| 35-39 | 5 | 7 | | | 12 | 62 | | 4 |
| 40-44 | 12 | 11 | | | | 18 | | 18 |
| 45-49 | 6 | 5 | 2 | | | 3 | | 38 |
| 50-54 | 2 | 2 | 2 | | | | | 14 |
| 55-59 | | | | 1 | | | | 1 |
| 60-64 | | | | 1 | | | | 1 |
| 65-69 | | | | 1 | | 1 | | |
| 70-74 | | | | | | | | |
| 75-79 | | | | | 1 | | | |
| 80-84 | 1 | 1 | | | 1 | 2 | | 2 |
| 85-89 | | 1 | 1 | | | | | |
| 90-94 | | | 2 | | | | | |
| 95-99 | | | | | | | | |
| 100- | | | 1 | | | | | |

Appendix IIIi. Length frequency distribution of *Gila robusta* collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | |
| 10-14 | | 1 | 2 |
| 15-19 | | | 25 |
| 20-24 | | | 89 |
| 25-29 | | | 72 |
| 30-34 | | | 35 |
| 35-39 | | | 26 |
| 40-44 | 3 | | 7 |
| 45-49 | 4 | 1 | |
| 50-54 | 9 | | 1 |
| 55-59 | 7 | 2 | |
| 60-64 | 7 | 3 | 1 |
| 65-69 | 1 | 2 | |
| 70-74 | 1 | 2 | 1 |
| 75-79 | | 1 | 2 |
| 80-84 | | | |
| 85-89 | | | |
| 90-94 | | | |
| 95-99 | | | |
| 100- | 3 | | |

Appendix IIIj. Length frequency distribution of <u>Gila robusta</u> collected by seine and dipnet from the White River in 1976.

| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | | | |
| 10-14 | | | | 13 | 4 | |
| 15-19 | | | | 11 | 13 | |
| 20-24 | | | | 8 | 38 | |
| 25-29 | | | | | 10 | |
| 30-34 | | | | | 8 | |
| 35-39 | | 1 | | | 4 | |
| 40-44 | | | | | | |
| 45-49 | | | | | | |
| 50-54 | | | | | | |
| 55-59 | | | | | | |
| 60-64 | | | | | | |
| 65-69 | | | | | | |
| 70-74 | | | | | | |
| 75-79 | | | | | | |
| 80-84 | | | | | | |
| 85-89 | | | | | | |
| 90-94 | | | | | | |
| 95-99 | | | | | | |
| 100- | | | | | | |

Appendix IIIk. Length frequency distribution of *Gila robusta* collected by seine and dipnet in the White River in 1977.

| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | | | |
| 10-14 | | | | |
| 15-19 | | | | 3 |
| 20-24 | | | | 6 |
| 25-29 | | | | 2 |
| 30-34 | | | | 1 |
| 35-39 | | | | 9 |
| 40-44 | | | | |
| 45-49 | | | | 1 |
| 50-54 | | | | |
| 55-59 | | | | |
| 60-64 | | | | |
| 65-69 | | | | |
| 70-74 | | | | |
| 75-79 | | | | |
| 80-84 | | 2 | | 1 |
| 85-89 | | | | |
| 90-94 | | | | |
| 95-99 | | | | |
| 100 | | | | |

Appendix IIII. Length frequency distribution of <u>Notropis stramineus</u>, collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | 82 | | | |
| 10-14 | | | | 1 | 63 | | | 1 |
| 15-19 | | | | | 12 | 5 | | 17 |
| 20-24 | 2 | 3 | | | 1 | 3 | | 84 |
| 25-29 | | 2 | | | | 7 | | 49 |
| 30-34 | | 1 | | | | 1 | | 47 |
| 35-39 | | | | 1 | | | | 17 |
| 40-44 | | | | 1 | | | | 3 |
| 45-49 | 1 | 1 | | 1 | 1 | 1 | | |
| 50-54 | 5 | 4 | 2 | | 3 | 5 | | |
| 55-59 | 6 | 1 | 4 | 2 | 3 | 1 | | |
| 60-64 | | 1 | 3 | 2 | 2 | | | |
| 65-69 | 1 | | | | 2 | | | |
| 70-74 | | | | | | | | |
| 75-79 | | | | | | | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | | | | | | | |
| 95-99 | | | | | | | | |

Appendix IIIm. Length frequency distribution of *Notropis stramineus* collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | 4 |
| 10-14 | | | 44 |
| 15-19 | | | 50 |
| 20-24 | | | 8 |
| 25-29 | 3 | | 1 |
| 30-34 | 13 | 3 | |
| 35-39 | 20 | 3 | |
| 40-44 | 11 | 7 | |
| 45-49 | 6 | 4 | |
| 50-54 | | 2 | 1 |
| 55-59 | | | 1 |
| 60-64 | | | |
| 65-69 | | | |
| 70-74 | | | |
| 75-79 | | | |
| 80-84 | | | |
| 85-89 | | | |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | |

Appendix IIIn. Length frequency distribution of <u>Pimephales promelas</u> collected by seine and dip net from the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | 22 | 25 | | |
| 10-14 | | | 5 | 1 | 34 | 639 | | |
| 15-19 | 1 | 11 | 1 | 3 | 5 | 164 | | 6 |
| 20-24 | 4 | 11 | 1 | 5 | 1 | 17 | | 19 |
| 25-29 | 13 | 7 | | 1 | 1 | 9 | | 55 |
| 30-34 | 24 | 3 | 2 | | 2 | 6 | | 32 |
| 35-39 | 16 | 4 | 3 | 1 | | 2 | | 24 |
| 40-44 | 9 | 1 | 2 | 10 | | 8 | | 8 |
| 45-49 | 7 | 3 | 2 | 10 | 9 | 9 | | 2 |
| 50-54 | 8 | | | 6 | | 2 | | |
| 55-59 | 3 | 2 | | | 5 | | | 1 |
| 60-64 | 3 | | | 1 | 2 | | | |
| 65-69 | 1 | 1 | | | | | | |
| 70-74 | | | | | | | | |
| 75-79 | 1 | | | | | | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | | | | | | | |
| 100- | | | | | | | | |

Appendix IIIo. Length frequency distribution of *Pimephales promelas* collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | 1 | 249 |
| 10-14 | | 2 | 174 |
| 15-19 | | | 291 |
| 20-24 | 3 | | 361 |
| 25-29 | 7 | | 161 |
| 30-34 | 10 | | 46 |
| 35-39 | 15 | | 11 |
| 40-44 | 4 | | 2 |
| 45-49 | 4 | | 1 |
| 50-54 | 5 | 2 | 3 |
| 55-59 | 2 | 1 | 2 |
| 60-64 | 2 | | 2 |
| 65-69 | | | |
| 70-74 | | | |
| 75-79 | | | |
| 80-84 | | | |
| 85-89 | | | |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | |

Appendix IIIp. Length frequency distribution of *Pimephales promelas* collected by seine and dipnet in the White River in 1976.

| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | | | |
| 10-14 | | | | | | |
| 15-19 | | | | | 2 | |
| 20-24 | | | | | 2 | |
| 25-29 | 2 | 1 | | 1 | 5 | |
| 30-34 | 7 | 2 | | | 1 | |
| 35-39 | 7 | 5 | | | 1 | |
| 40-44 | 4 | 7 | 1 | | 1 | |
| 45-49 | 4 | 1 | 1 | | 3 | |
| 50-54 | 3 | | 2 | | 2 | |
| 55-59 | 1 | | 1 | | 1 | 1 |
| 60-64 | | | | | | |
| 65-69 | | | | | | |
| 70-74 | | | | | | |
| 75-79 | | | | | | |
| 80-84 | | | | | | |
| 85-89 | | | | | | |
| 90-94 | | | | | | |
| 95-99 | | | | | | |
| 100- | | | | | | |

Appendix IIIq. Length frequency distribution of *Pimephales promelas* collected by seine and dipnet in the White River in 1977.

| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | | | |
| 10-14 | | | | |
| 15-19 | | | | 4 |
| 20-24 | | | | 1 |
| 25-29 | | | | |
| 30-34 | | | | |
| 35-39 | 4 | | | |
| 40-44 | 1 | | | |
| 45-49 | | | | |
| 50-54 | | 1 | | |
| 55-59 | | 1 | | |
| 60-64 | | 1 | | |
| 65-69 | | | | |
| 70-74 | | | | |
| 75-79 | | | | |
| 80-84 | | | | |
| 85-89 | | | | |
| 90-94 | | | | |
| 95-99 | | | | |
| 100- | | | | |

Appendix IIIr. Length frequency distribution of <u>Rhinichthys osculus</u> collected by seine and dipnet in the Yampa River in 1976.

| | May 20 | June 1 | June 24 | July 16 | August 6 | August 18 | September | October 10 |
|---|---|---|---|---|---|---|---|---|
| 0-4 | | | | | | | | |
| 5-9 | | | | 60 | 155 | 6 | | |
| 10-14 | | | | 122 | 217 | 70 | | |
| 15-19 | | | | 41 | 315 | 94 | | |
| 20-24 | 9 | 5 | | 14 | 204 | 119 | | |
| 25-29 | 39 | 37 | 8 | | 78 | 151 | | 12 |
| 30-34 | 49 | 89 | 14 | | 12 | 78 | | 8 |
| 35-39 | 53 | 46 | 18 | | 2 | 29 | | 11 |
| 40-44 | 58 | 39 | 13 | 10 | 1 | 5 | | 4 |
| 45-49 | 34 | 22 | 11 | 7 | 4 | 2 | | 3 |
| 50-54 | 2 | 8 | 5 | 10 | 5 | 3 | | |
| 55-59 | 3 | 3 | 2 | 2 | 4 | 5 | | |
| 60-64 | 10 | 3 | 1 | 1 | 2 | 3 | | |
| 65-69 | 5 | 1 | | | 2 | 2 | | 1 |
| 70-74 | 6 | | 1 | | | 2 | | 2 |
| 75-79 | 2 | | | | 2 | 1 | | |
| 80-84 | | | | 1 | | | | 1 |
| 85-89 | | 1 | | | 4 | | | 2 |
| 90-94 | | | | | | 1 | | |
| 95-99 | | | | | | | | |
| 100- | | | | | 1 | | | |

Appendix IIIs. Length frequency distribution of *Rhinichthys osculus* collected by seine and dipnet in the Yampa River in 1977

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | 10 | |
| 10-14 | | 53 | 18 |
| 15-19 | | 3 | 118 |
| 20-24 | 1 | 11 | 157 |
| 25-29 | 3 | 1 | 122 |
| 30-34 | 11 | | 58 |
| 35-39 | 22 | | 6 |
| 40-44 | 11 | | 2 |
| 45-49 | 7 | 1 | |
| 50-54 | 5 | 4 | |
| 55-59 | 2 | 1 | 6 |
| 60-64 | 1 | 1 | 2 |
| 65-69 | | 2 | 2 |
| 70-74 | 2 | 1 | |
| 75-79 | | | 1 |
| 80-84 | 1 | 1 | 1 |
| 85-89 | | | 2 |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | |

Appendix IIIt. Length frequency of *Rhinichthys osculus* collected by seine and dipnet in the White River in 1976.

| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | 77 | 1 | |
| 10-14 | | | | 53 | 25 | |
| 15-19 | | | | 11 | 66 | |
| 20-24 | 5 | | 1 | 1 | 59 | |
| 25-29 | 50 | 7 | 1 | | 35 | |
| 30-34 | 137 | 26 | 3 | | 11 | |
| 35-39 | 173 | 17 | 9 | | | |
| 40-44 | 78 | 18 | 3 | | | |
| 45-49 | 5 | 2 | 2 | | | |
| 50-54 | 2 | | 2 | 3 | 1 | |
| 55-59 | 4 | 2 | 1 | 1 | 4 | |
| 60-64 | 7 | 2 | | | 5 | |
| 65-69 | 4 | 2 | 5 | | 3 | 2 |
| 70-74 | 2 | 1 | 1 | 2 | | 2 |
| 75-79 | 2 | | 1 | 1 | 1 | 3 |
| 80-84 | 1 | 1 | | | 1 | 4 |
| 85-89 | 1 | | 2 | | | 1 |
| 90-94 | 2 | | 1 | | 1 | |
| 95-99 | | | | | 1 | |
| 100- | | | | | | |

Appendix IIIu. Length frequency distribution of <u>Rhinichthys</u> <u>osculus</u> collected by seine and dipnet in the White River in 1977.

| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | 15 | | |
| 10-14 | | 49 | | 3 |
| 15-19 | | 17 | | 6 |
| 20-24 | | 1 | | 11 |
| 25-29 | | | | 6 |
| 30-34 | | | | 5 |
| 35-39 | 1 | | | 3 |
| 40-44 | | | | |
| 45-49 | 3 | | | 1 |
| 50-54 | 5 | | | |
| 55-59 | 1 | 4 | | 6 |
| 60-64 | 1 | | | 10 |
| 65-69 | 1 | | | 7 |
| 70-74 | | | | 5 |
| 75-79 | 1 | | | 2 |
| 80-84 | 1 | | | 1 |
| 85-89 | | | | 1 |
| 90-94 | | | | 1 |
| 95-99 | | | | |
| 100- | | | | |

Appendix IIIv. Length frequency distribution of <u>Richardsonius</u> <u>balteatus</u> collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | 40 | 82 | 3 | | |
| 10-14 | | | | 8 | 215 | 91 | | |
| 15-19 | 18 | 2 | 2 | | 192 | 92 | | 3 |
| 20-24 | 359 | 53 | 7 | | 41 | 174 | | 44 |
| 25-29 | 497 | 103 | 27 | 5 | 17 | 199 | | 208 |
| 30-34 | 158 | 49 | 22 | 26 | 6 | 66 | | 202 |
| 35-39 | 23 | 22 | 26 | 75 | 1 | 15 | | 255 |
| 40-44 | 6 | 5 | 13 | 83 | 1 | 3 | | 153 |
| 45-49 | 15 | 12 | 2 | 67 | 8 | 5 | | 86 |
| 50-54 | 25 | 19 | 6 | 18 | 30 | 4 | | 35 |
| 55-59 | 39 | 43 | 12 | 20 | 32 | 27 | | 10 |
| 60-64 | 28 | 39 | 18 | 20 | 14 | 26 | | 28 |
| 65-69 | 24 | 15 | 15 | 15 | | 10 | | 24 |
| 70-74 | 5 | 4 | 3 | 8 | 3 | 1 | | 6 |
| 75-79 | 2 | | 8 | 2 | 2 | | | 2 |
| 80-84 | 2 | 1 | 1 | | 1 | | | 1 |
| 85-89 | 5 | | | 2 | | | | 1 |
| 90-94 | 2 | | 1 | 2 | | | | |
| 95-99 | | | | | | | | |
| 100 | | | | | | | | |

Appendix III W. Length frequency distribution of <u>Richardsonius balteatus</u> collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | |
| 10-14 | | | 7 |
| 15-19 | | | 149 |
| 20-24 | | | 220 |
| 25-29 | 6 | | 122 |
| 30-34 | 91 | | 176 |
| 35-39 | 85 | | 104 |
| 40-44 | 94 | | 4 |
| 45-49 | 66 | 5 | |
| 50-54 | 20 | 3 | 1 |
| 55-59 | 10 | 3 | 8 |
| 60-64 | 9 | 2 | 7 |
| 65-69 | | | 20 |
| 70-74 | 5 | 1 | 14 |
| 75-79 | 6 | 1 | |
| 80-84 | 3 | | 1 |
| 85-89 | 1 | | |
| 90-94 | 1 | | |
| 95-99 | 2 | | |
| 100- | | | |

Appendix IIIx. Length frequency distribution of *Catostomus commersoni* collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | | | | |
| 10-14 | | | | 87 | 5 | | | |
| 15-19 | | | | 335 | 66 | 2 | | |
| 20-24 | | | | 4 | 35 | 27 | | |
| 25-29 | 4 | | | | 13 | 57 | | |
| 30-34 | 8 | 1 | | | 2 | 21 | | 2 |
| 35-39 | 9 | 4 | 1 | | | 9 | | 1 |
| 40-44 | 18 | 2 | | | | 6 | | 4 |
| 45-49 | 12 | 5 | 3 | | | 2 | | 6 |
| 50-54 | 4 | 3 | 1 | 1 | | | | 2 |
| 55-59 | 3 | 2 | | | | | | 4 |
| 60-64 | | | | | | | | 1 |
| 65-69 | | | 1 | 1 | | | | 1 |
| 70-74 | | | | | | | | |
| 75-79 | | | | | | | | |
| 80-84 | | | 1 | | | | | |
| 85-89 | | | | | 1 | 1 | | |
| 90-94 | | | | | | | | |
| 95-99 | 1 | | | | 1 | | | |

Appendix IIIy. Length frequency distribution of *Catostomus commersoni* collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | 1 | |
| 10-14 | | 246 | |
| 15-19 | | 91 | 22 |
| 20-24 | | 6 | 37 |
| 25-29 | | | 19 |
| 30-34 | | | 13 |
| 35-39 | 4 | | 10 |
| 40-44 | 5 | | 5 |
| 45-49 | 4 | | 1 |
| 50-54 | 3 | 1 | 1 |
| 55-59 | 1 | 1 | |
| 60-64 | 4 | | |
| 65-69 | 4 | | |
| 70-74 | 1 | | |
| 75-79 | 2 | | |
| 80-84 | 1 | | 1 |
| 85-89 | 1 | | |
| 90-94 | | | 1 |
| 95-99 | 1 | | |
| 100- | 2 | | |

Appendix IIIz. Length frequency distribution of Catostomus discobolus collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | |
| 10-14 | | 106 | 1 |
| 15-19 | | 151 | 25 |
| 20-24 | | 8 | 79 |
| 25-29 | | | 78 |
| 30-34 | 2 | | 54 |
| 35-39 | 2 | | 22 |
| 40-44 | 8 | | 5 |
| 45-49 | 3 | | 1 |
| 50-54 | 2 | | |
| 55-59 | 1 | | |
| 60-64 | 2 | | 2 |
| 65-69 | | | |
| 70-74 | 1 | | |
| 75-79 | | | |
| 80-84 | 2 | | 1 |
| 85-89 | | | |
| 90-94 | 1 | | 2 |
| 95-99 | | | |

Appendix IIIaa. Length frequency distribution of <u>Catostomus discobolus</u> collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | | | | |
| 10-14 | | | | 209 | 14 | | | |
| 15-19 | | | | 300 | 194 | 75 | | |
| 20-24 | | 1 | | 22 | 112 | 143 | | 1 |
| 25-29 | 10 | 3 | | 1 | 17 | 198 | | 3 |
| 30-34 | 81 | 4 | | | 1 | 67 | | 11 |
| 35-39 | 92 | 12 | 6 | | 1 | 121 | | 7 |
| 40-44 | 40 | 12 | 5 | | | | | 5 |
| 45-49 | 16 | 5 | 6 | | | | | 5 |
| 50-54 | 4 | 2 | 2 | 1 | | | | 2 |
| 55-59 | | 1 | 1 | 3 | | | | |
| 60-64 | | | | 2 | 1 | | | |
| 65-69 | | | | | | | | |
| 70-74 | | | | 1 | | | | |
| 75-79 | | | | | 1 | | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | 1 | | | | | | |
| 95-99 | | | | | | | | |
| 100- | | | | | | | | |

Appendix IIIbb. Length frequency distribution of <u>Catostomus discobolus</u> collected by seine and dipnet in the White River in 1976.

| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | | | |
| 10-14 | | | | 1 | 1 | |
| 15-19 | | | | 112 | 14 | |
| 20-24 | | | | 110 | 73 | |
| 25-29 | | 1 | | 1 | 110 | |
| 30-34 | 9 | 8 | 1 | | 25 | |
| 35-39 | 13 | 11 | 4 | | | |
| 40-44 | 4 | 4 | 1 | | | |
| 45-49 | 3 | | | | | |
| 50-54 | 5 | 1 | 1 | | | |
| 55-59 | | | 1 | | | |
| 60-64 | | | | | | |
| 65-69 | | | | | | 1 |
| 70-74 | | | | | | |
| 75-79 | | | | | | |
| 80-84 | | | | | | |
| 85-89 | | | | | | |
| 90-94 | 1 | | | | | |
| 95-99 | 3 | | | | | |
| 100- | | | | | | |

Appendix IIIcc. Length frequency distribution of *Catostomus discobolus* collected by seine and dipnet in the White River in 1977.

| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | | | |
| 10-14 | | 6 | | |
| 15-19 | | 14 | | |
| 20-24 | | 21 | | 1 |
| 25-29 | | 2 | | 1 |
| 30-34 | | | | |
| 35-39 | 1 | | | 1 |
| 40-44 | 2 | | | |
| 45-49 | 1 | | | 4 |
| 50-54 | 2 | | | |
| 55-59 | | 1 | | |
| 60-64 | | | | |
| 65-69 | | 2 | | |
| 70-74 | | 4 | | |
| 75-79 | | 2 | | |
| 80-84 | | | | |
| 85-89 | | | | |
| 90-94 | | | | |
| 95-99 | | | | |
| 100- | | | | |

Appendix IIIdd. Length frequency distribution of *Catostomus latipinnis* collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | | | | |
| 10-14 | | | 5 | | | | | |
| 15-19 | | | 932 | 125 | 4 | | | |
| 20-24 | | | 1 | 122 | 34 | 9 | | 1 |
| 25-29 | | | | 24 | 35 | 42 | | |
| 30-34 | 4 | 1 | | 5 | 21 | 36 | | 2 |
| 35-39 | 5 | | | 1 | 17 | 30 | | 1 |
| 40-44 | 6 | | 2 | | 2 | 16 | | 3 |
| 45-49 | 5 | 3 | | | 3 | 8 | | 1 |
| 50-54 | 1 | 1 | 1 | | | 2 | | 1 |
| 55-59 | 3 | 3 | 3 | | | | | |
| 60-64 | 3 | 3 | 1 | | | | | |
| 65-69 | 1 | 1 | 1 | | | | | |
| 70-74 | | | 2 | | | | | |
| 75-79 | 1 | 1 | 1 | | | | | |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | |
| 90-94 | | | | | | | | |
| 95-99 | | | 1 | | | | | |
| 100- | | | | | | | | |

Appendix IIIee. Length frequency distribution of *Catostomus latipinnis* collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | |
| 10-14 | | 4 | |
| 15-19 | | 113 | 1 |
| 20-24 | | 298 | 10 |
| 25-29 | | 140 | 57 |
| 30-34 | | 17 | 96 |
| 35-39 | | 2 | 101 |
| 40-44 | | | 52 |
| 45-49 | 1 | | 20 |
| 50-54 | 2 | | 1 |
| 55-59 | | | 1 |
| 60-64 | 2 | | |
| 65-69 | | | |
| 70-74 | | | |
| 75-79 | 2 | | |
| 80-84 | 1 | | |
| 85-89 | | | |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | 2 |

Appendix IIIff. Length frequency distribution of *Catostomus latipinnis* collected by seine and dipnet in the White River in 1976.

| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | | | |
| 10-14 | | | 5 | | | |
| 15-19 | | | 276 | 26 | 1 | |
| 20-24 | | | 4 | 151 | 9 | |
| 25-29 | | | | 50 | 28 | |
| 30-34 | | | | 9 | 13 | |
| 35-39 | | 1 | | 6 | 5 | |
| 40-44 | 1 | | | | 4 | |
| 45-49 | 3 | | | 1 | 2 | |
| 50-54 | 7 | | | | | |
| 55-59 | 1 | 1 | 1 | | | |
| 60-64 | 1 | | | | | |
| 65-69 | | | | | | |
| 70-74 | | | | | | |
| 75-79 | | | | | | |
| 80-84 | 1 | | | | | |
| 85-89 | | | 1 | | | 1 |
| 90-94 | 1 | | | | | |
| 95-99 | | | | | | |
| 100- | | | | | | 1 |

Appendix IIIgg. Length frequency distribution of Catostomus latipinnis collected by seine and dipnet in the White River in 1977.

| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | | | |
| 10-14 | | | | |
| 15-19 | | 5 | | |
| 20-24 | | 50 | | |
| 25-29 | | 69 | | |
| 30-34 | | 21 | | |
| 35-39 | | 7 | | |
| 40-44 | | 2 | | |
| 45-49 | 1 | | | 3 |
| 50-54 | | | | 4 |
| 55-59 | | | | 4 |
| 60-64 | | | | 1 |
| 65-69 | | | | 1 |
| 70-74 | | | | |
| 75-79 | | 1 | | |
| 80-84 | | 3 | | |
| 85-89 | | 8 | | |
| 90-94 | | 4 | | |
| 95-99 | | 2 | | |
| 100- | | | | |

Appendix IIIhh. Length frequency distribution of <u>Cottus bairdi</u> collected by seine and dipnet in the Yampa River in 1976.

| | May | June | | July | August | | September | October |
|---|---|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 18 | | 10 |
| 0-4 | | | | | | | | |
| 5-9 | | | | | | | | |
| 10-14 | | | 9 | 7 | | | | |
| 15-19 | | | 4 | 8 | | | | |
| 20-24 | | | 1 | | 1 | 2 | | |
| 25-29 | | | | 1 | 3 | 1 | | |
| 30-34 | | | | | 2 | 4 | | |
| 35-39 | | | | | | 1 | | |
| 40-44 | | | 1 | | | | | |
| 45-49 | | | | | | | | 1 |
| 50-54 | | | 1 | | | | | 4 |
| 55-59 | | 2 | | | | | | |
| 60-64 | | 2 | 3 | | | | | |
| 65-69 | | | 2 | 2 | | | | |
| 70-74 | | | | | | | | |
| 75-79 | | | | | | | | 1 |
| 80-84 | | | | | | | | |
| 85-89 | | | | | | | | 1 |
| 90-94 | | | | | | 1 | | |
| 95-99 | | | | | | | | |
| 100- | | | | | | | | |

Appendix IIIii. Length frequency distribution of _Cottus bairdi_ collected by seine and dipnet in the Yampa River in 1977.

| | May | June | July |
|---|---|---|---|
| | 26 | 28 | 28 |
| 0-4 | | | |
| 5-9 | | | |
| 10-14 | | | |
| 15-19 | | | |
| 20-24 | | | |
| 25-29 | | | 2 |
| 30-34 | | | 3 |
| 35-39 | | | |
| 40-44 | | | 1 |
| 45-49 | | | |
| 50-54 | 1 | | |
| 55-59 | | | |
| 60-64 | | | |
| 65-69 | 1 | 2 | |
| 70-74 | 3 | | 2 |
| 75-79 | | 1 | |
| 80-84 | | | |
| 85-89 | | 1 | 1 |
| 90-94 | | | |
| 95-99 | | | |
| 100- | | | |

Appendix IIIjj. Length frequency distribution of *Cottus bairdi* collected by seine and dipnet in the White River in 1976.

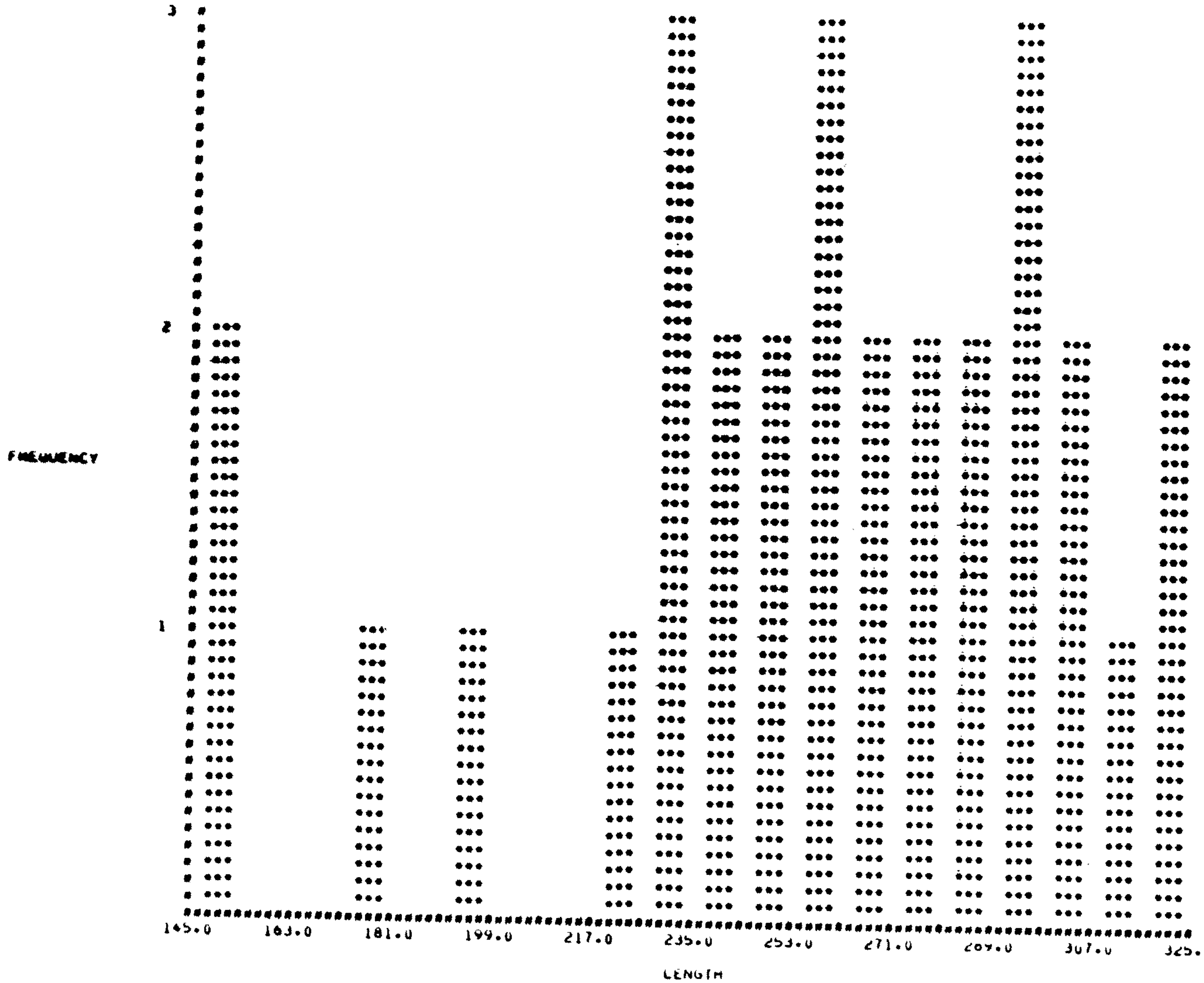
| | May | June | | July | August | |
|---|---|---|---|---|---|---|
| | 20 | 1 | 24 | 16 | 6 | 26 |
| 0-4 | | | | | | |
| 5-9 | | | | | | |
| 10-14 | | | 19 | | | |
| 15-19 | | | 8 | 2 | | |
| 20-24 | | | 1 | 4 | | |
| 25-29 | | 1 | | 3 | 4 | |
| 30-34 | | | | | 3 | |
| 35-39 | | | | | 7 | |
| 40-44 | | | | | | |
| 45-49 | 1 | | | | | |
| 50-54 | | | | | | |
| 55-59 | | | | | | |
| 60-64 | | | | | | |
| 65-69 | | | | | | |
| 70-74 | | | | | | |
| 75-79 | | | | | | |
| 80-84 | | | | | | |
| 85-89 | | | | | | |
| 90-94 | | | | | | |
| 95-99 | | | | | 1 | |
| 100- | | | | | | |

Appendix IIIkk. Length frequency distribution of <u>Cottus bairdi</u> collected by seine and dipnet in the White River in 1977.

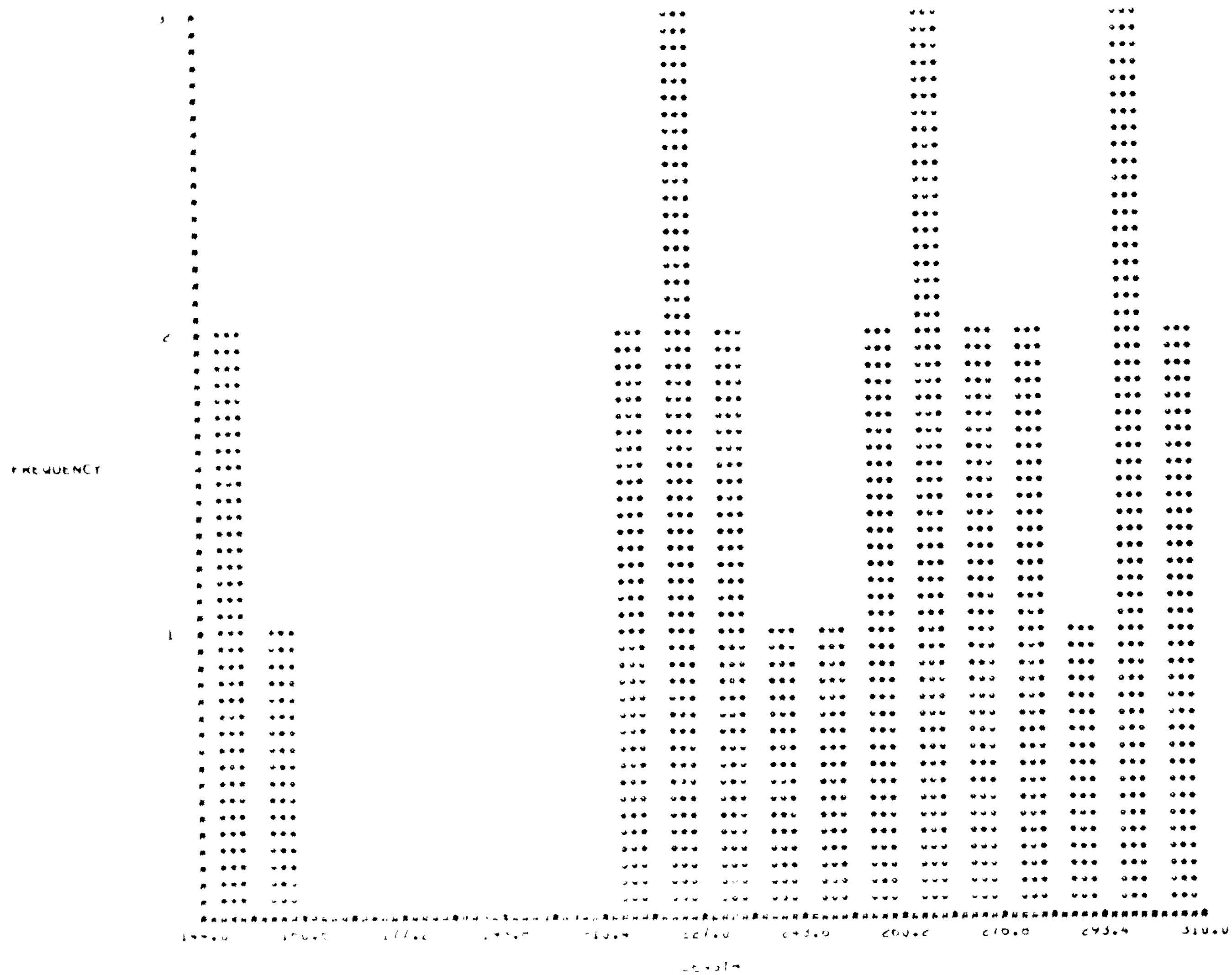
| | May | June | July | August |
|---|---|---|---|---|
| | 27 | 28 | | 1 |
| 0-4 | | | | |
| 5-9 | | | | |
| 10-14 | | | | |
| 15-19 | | | | |
| 20-24 | | | | |
| 25-29 | | | | |
| 30-34 | | | | |
| 35-39 | | | | |
| 40-44 | | | | |
| 45-49 | | | | |
| 50-54 | | | | |
| 55-59 | 2 | | | |
| 60-64 | 1 | | | |
| 65-69 | 1 | | | |
| 70-74 | 1 | | | |
| 75-79 | | | | |
| 80-84 | | | | 1 |
| 85-89 | | | | |
| 90-94 | 1 | | | |
| 95-99 | | | | |
| 100- | | | | |

# APPENDIX IV.

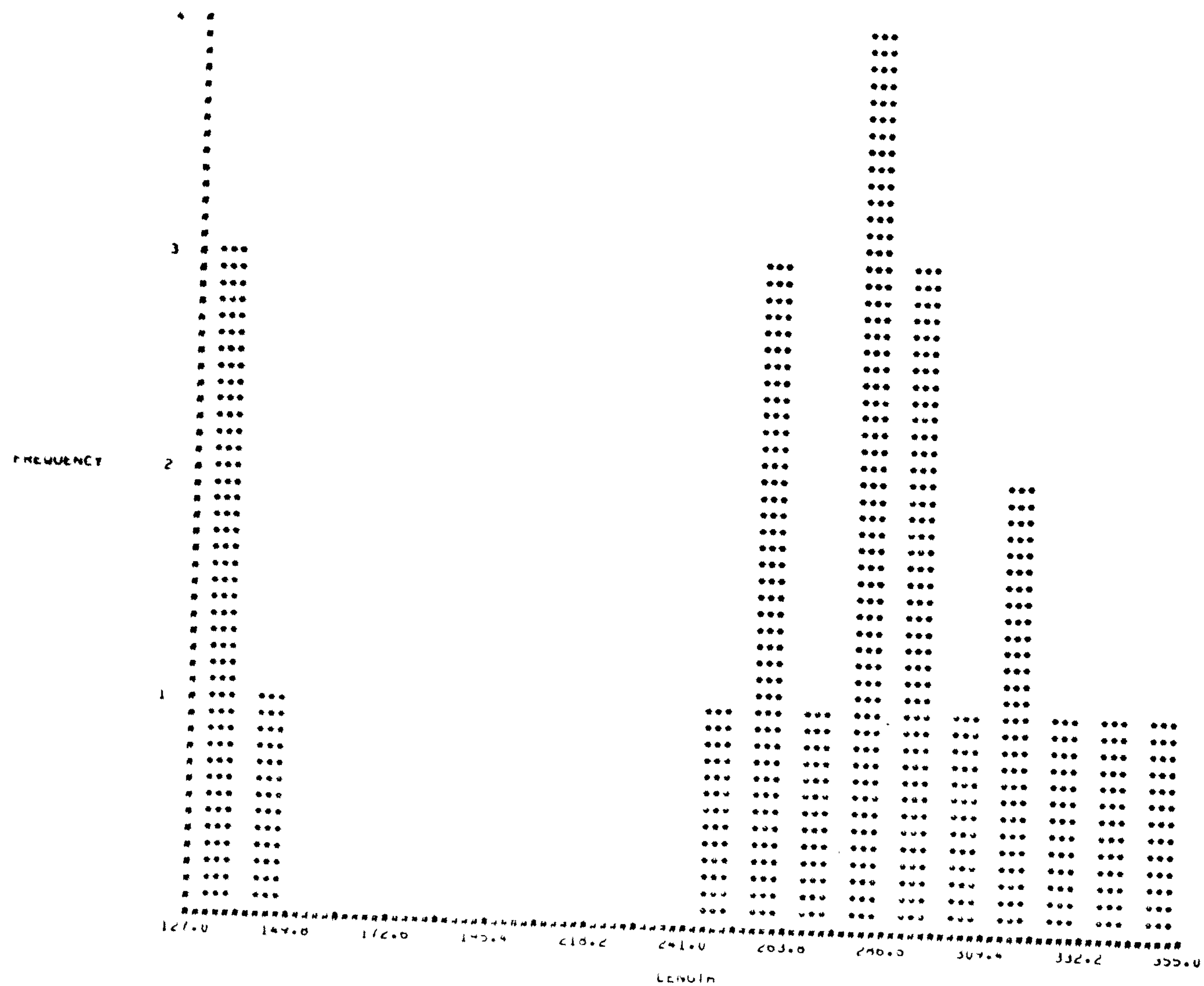
Length-frequency histograms for White and Yampa River fishes collected in 1976 and 1977.



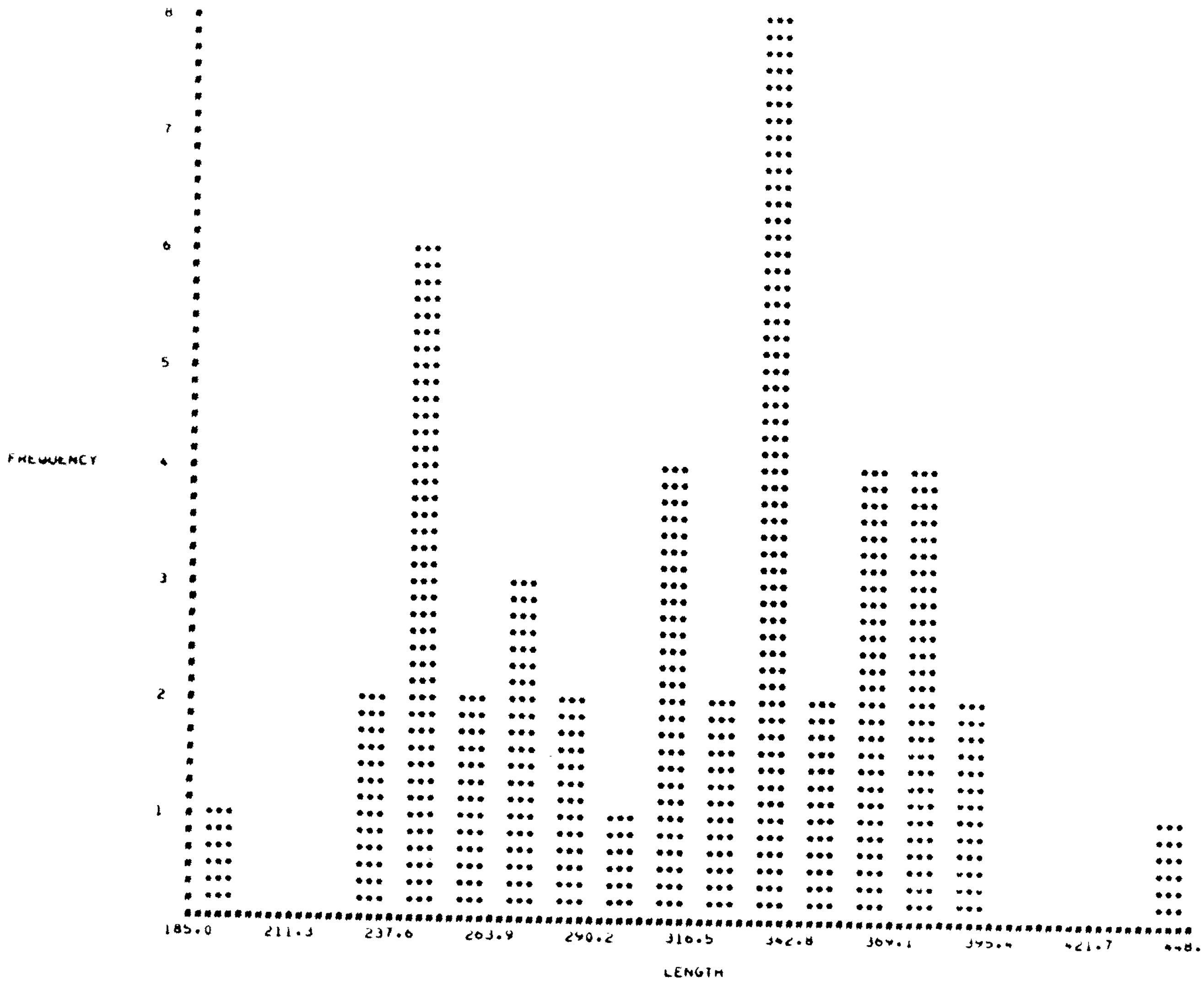

Appendix IVa. Length (mm) frequency of <u>Prosopium williamsoni</u> collected at Station Y-1, 1975.



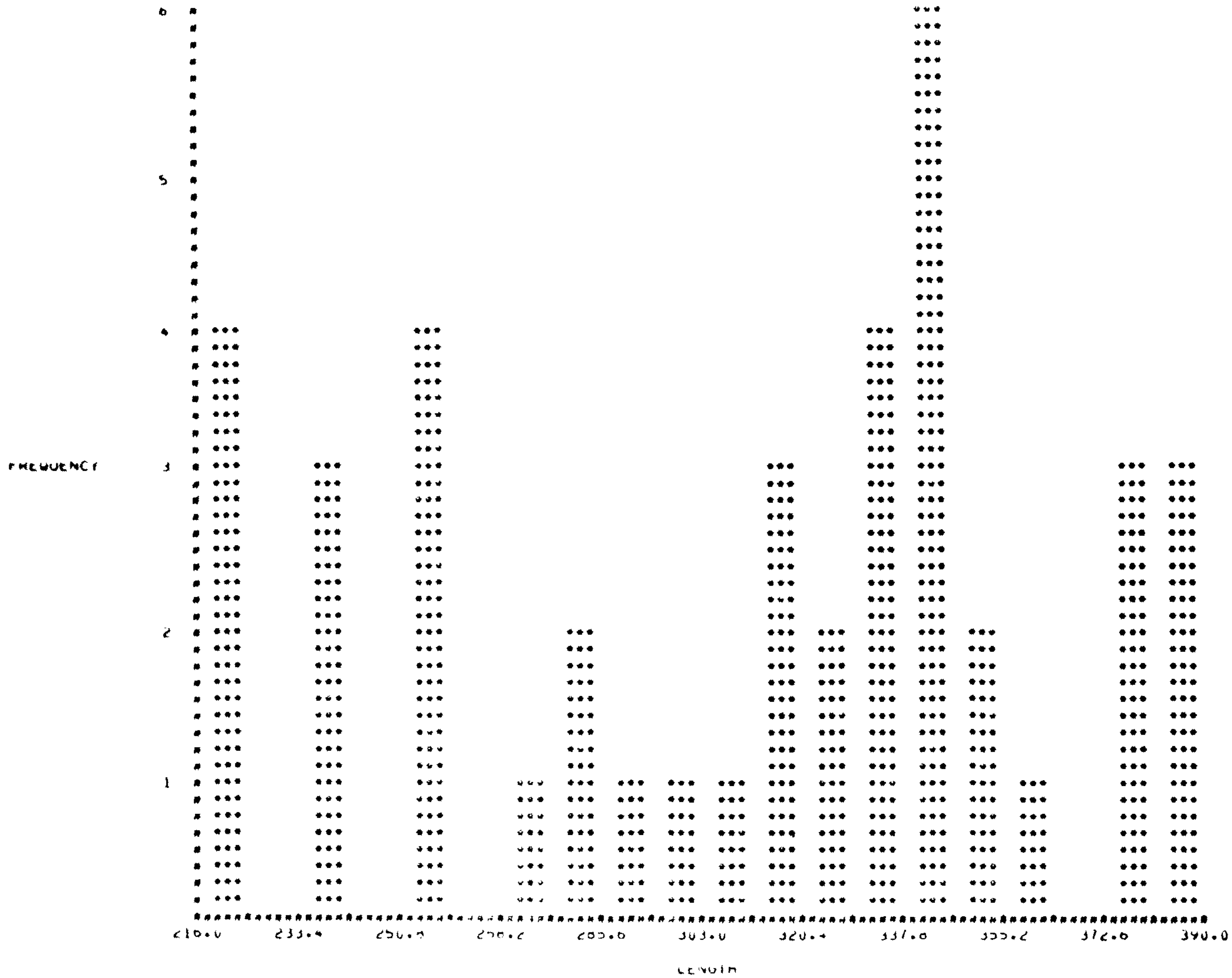

Appendix IVb. Length (mm) frequency of *Prosopium williamsoni* collected at Station Y-1, 1976.



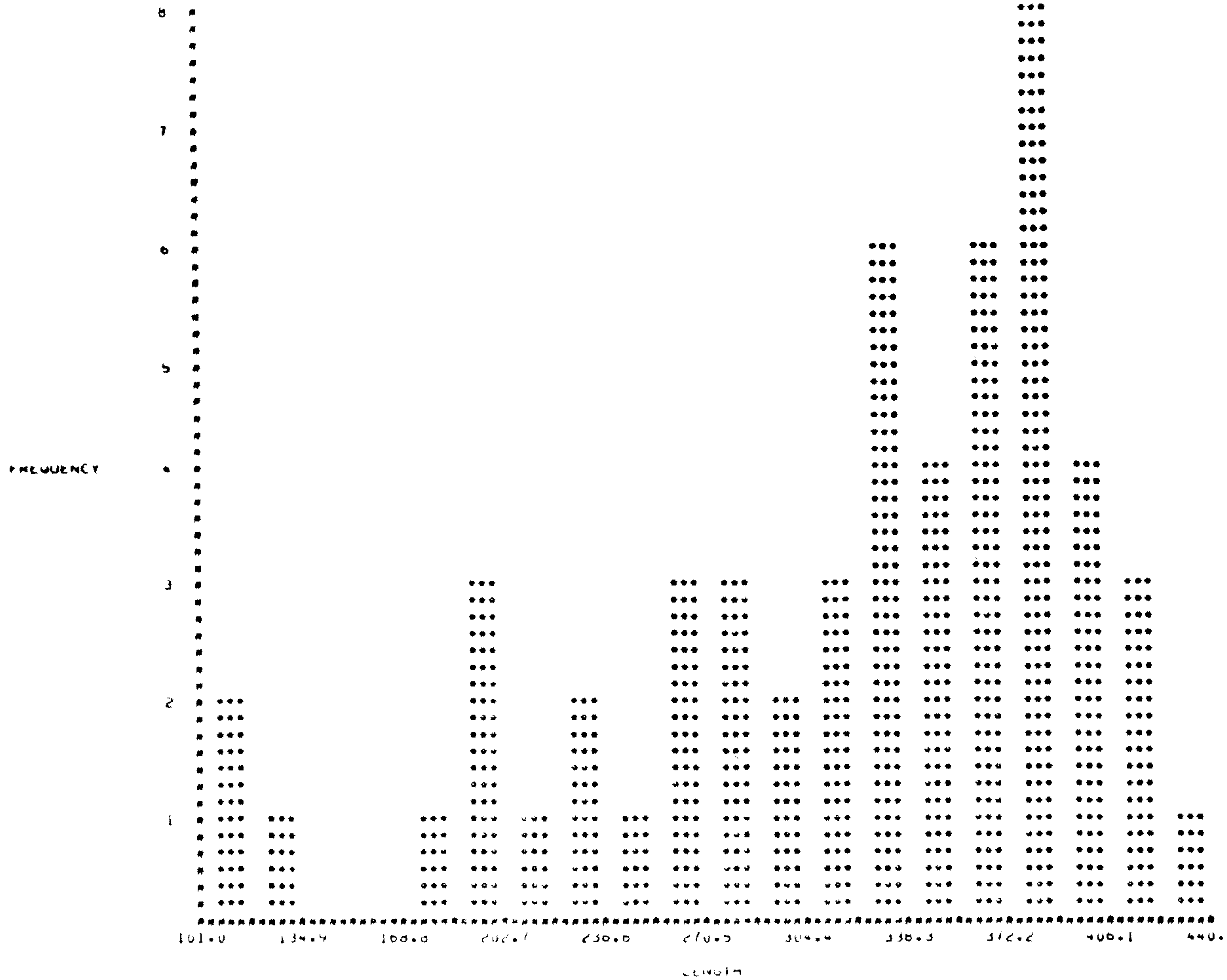

Appendix IVc. Length (mm) frequency of <u>Prosopium williamsoni</u> collected at Station Y-2, 1976.



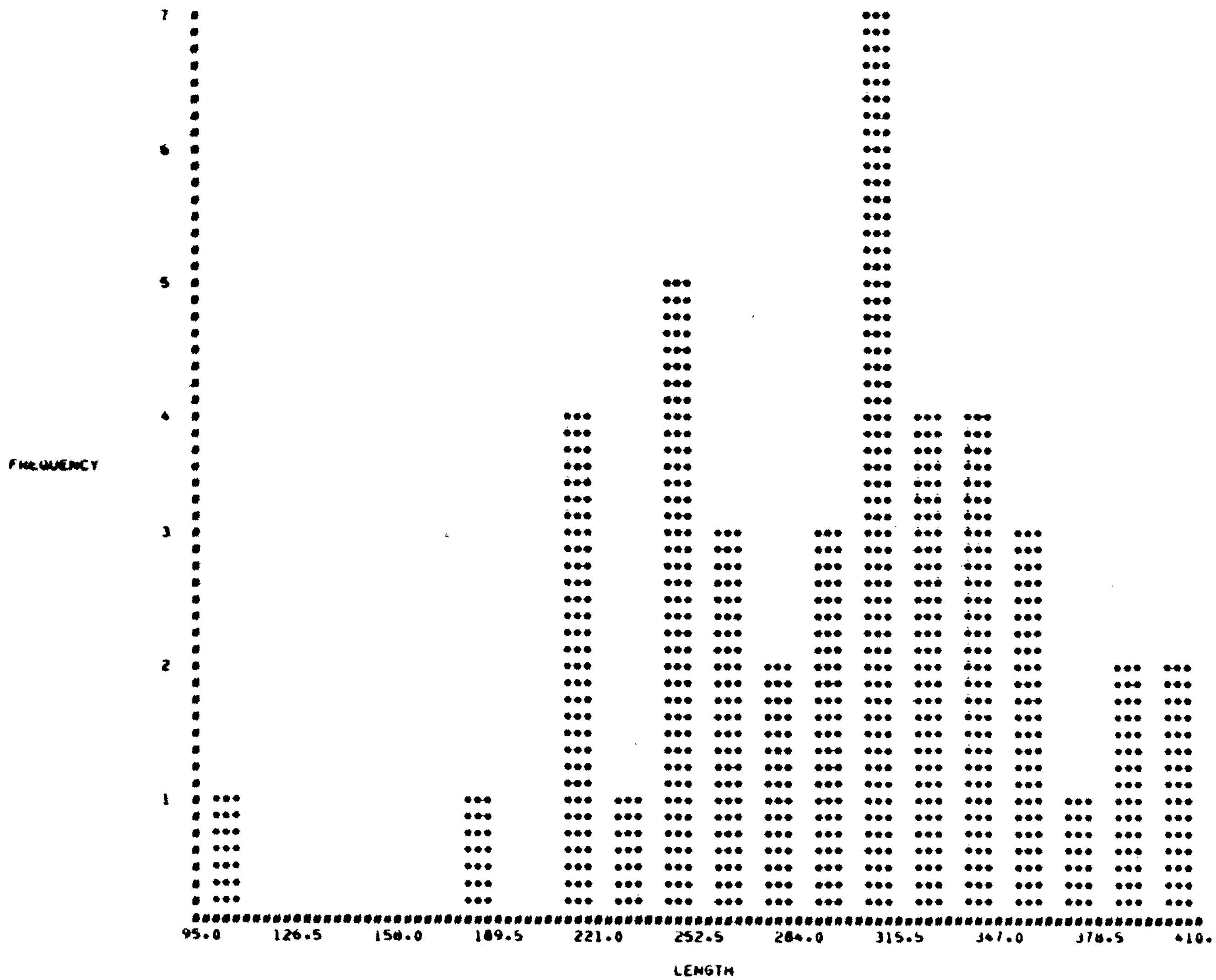

Appendix IVd. Length (mm) frequency of Catostomus commersoni collected at Station Y-2, 1975.



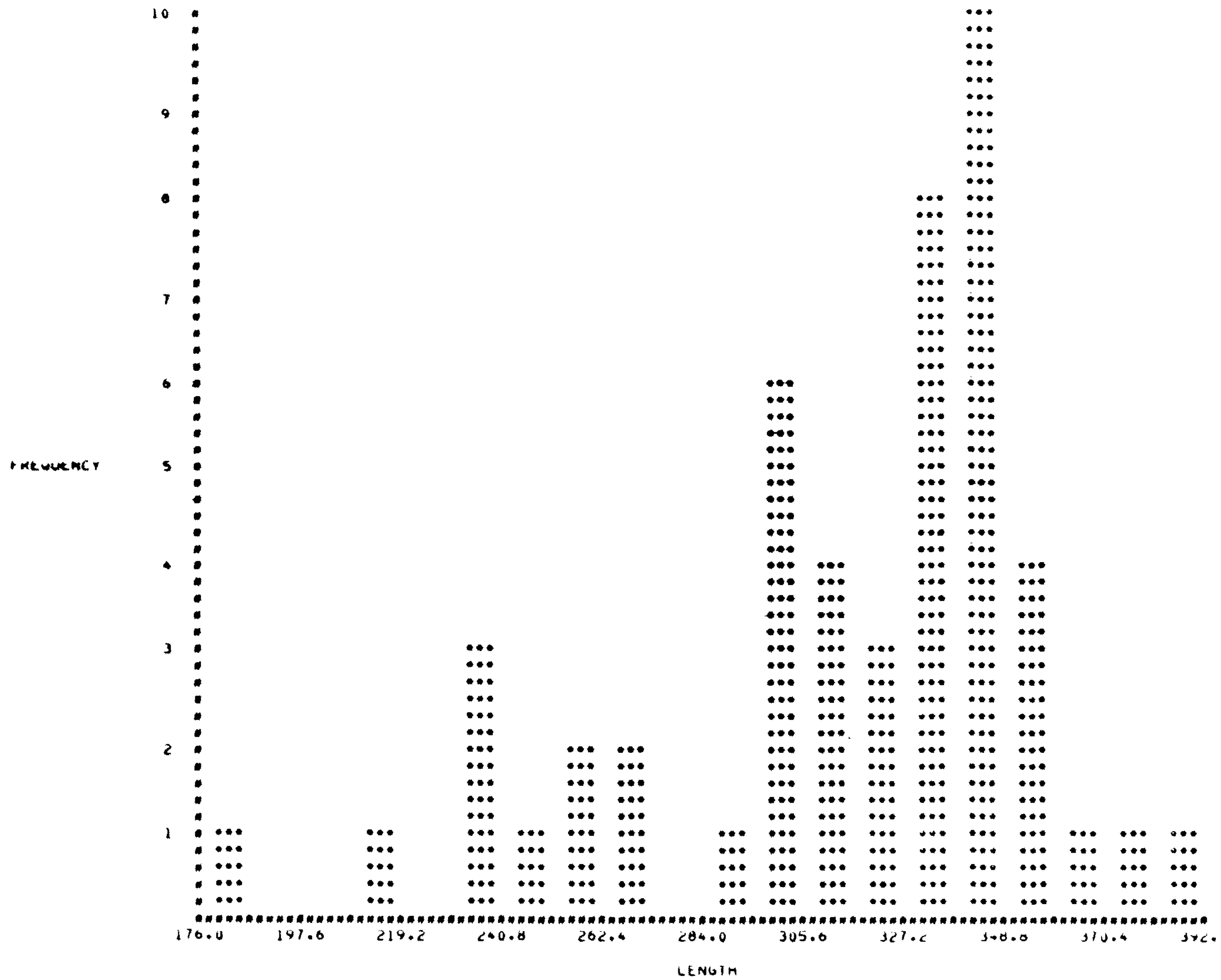

Appendix IVe. Length (mm) frequency of Catostomus commersoni collected at Station Y-1, 1976.



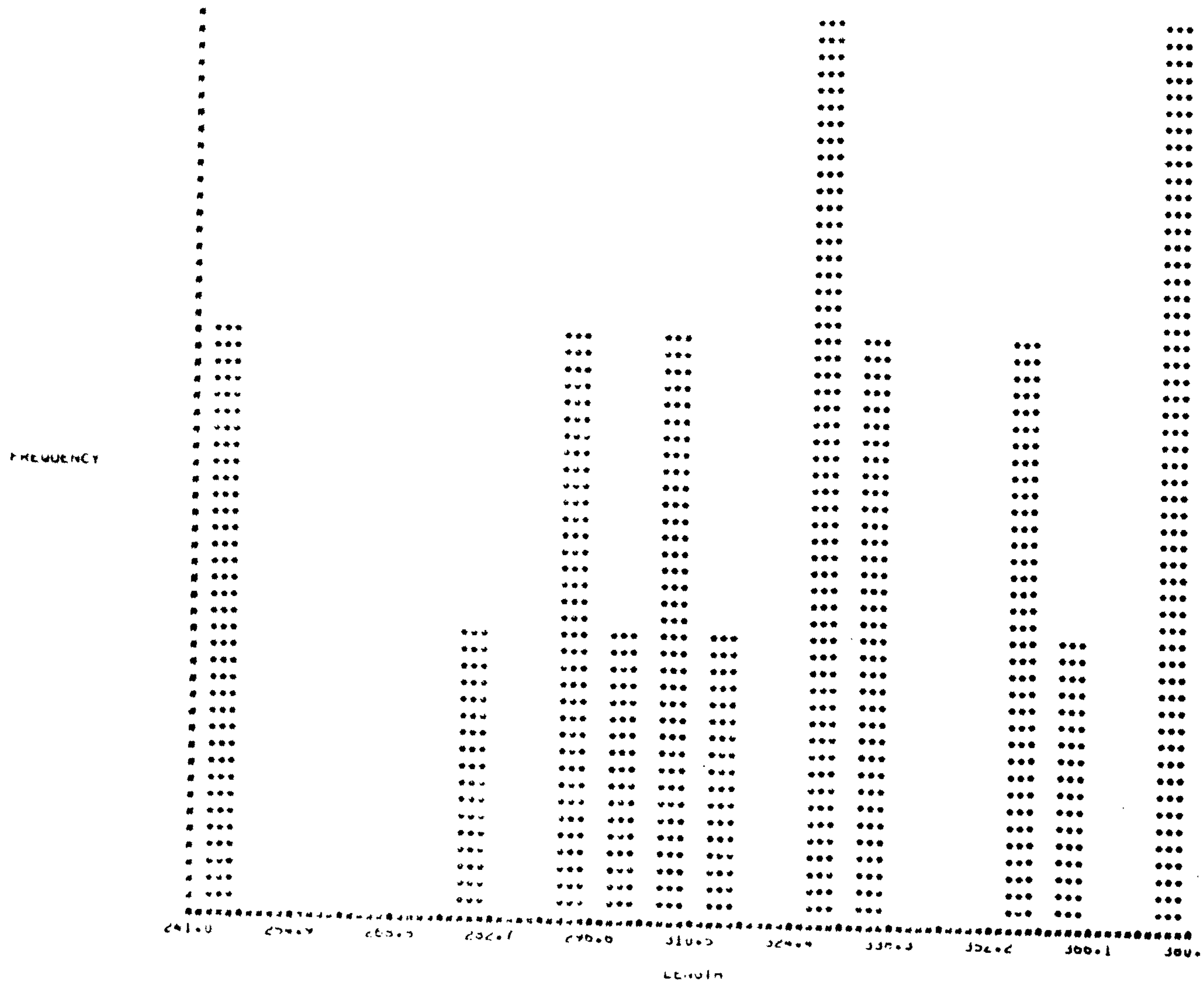

Appendix IVf. Length (mm) frequency of Catostomus commersoni collected at Station Y-2, 1976.



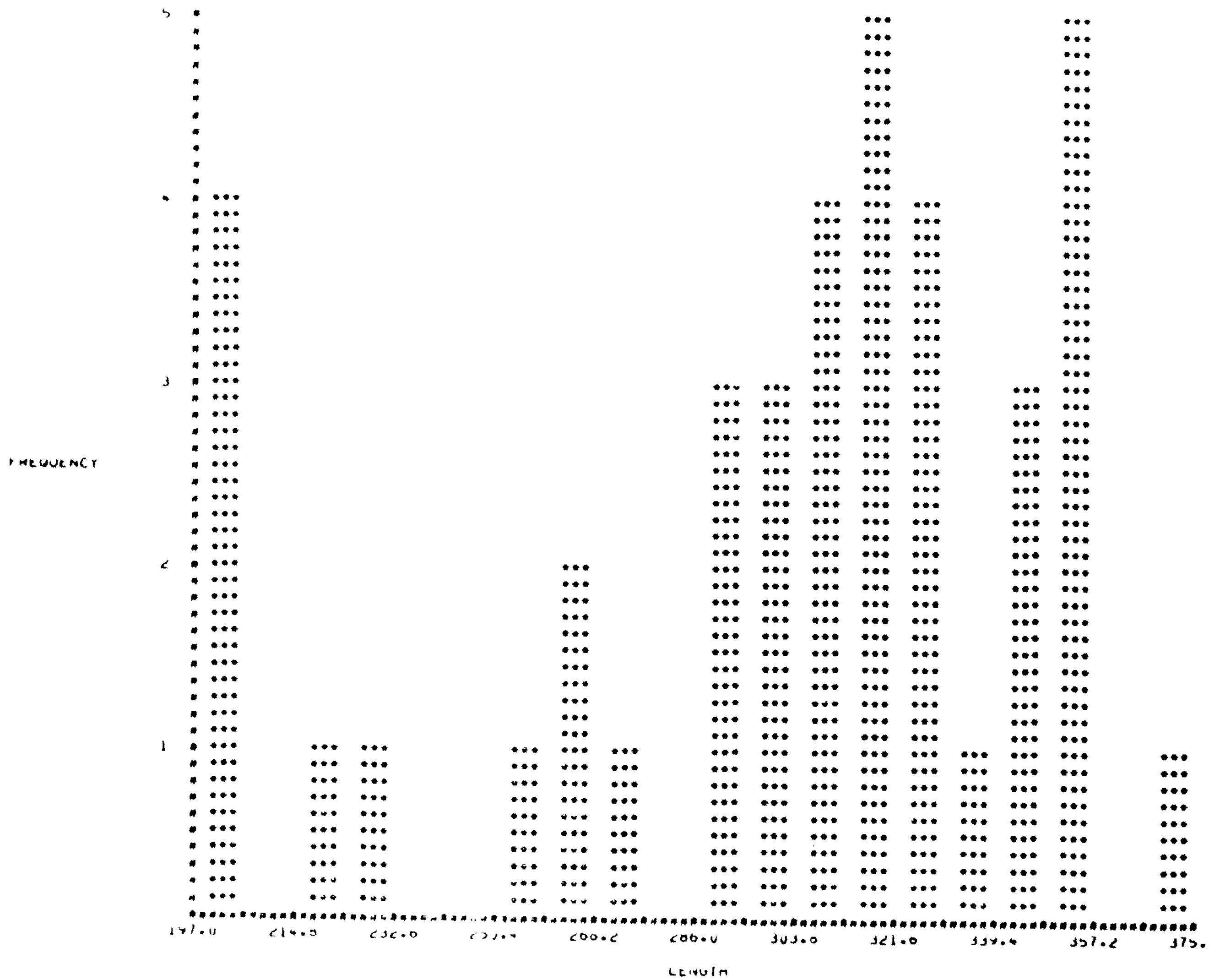

Appendix IVg. Length (mm) frequency of Catostomus commersoni collected at Station Y-1, 1977.



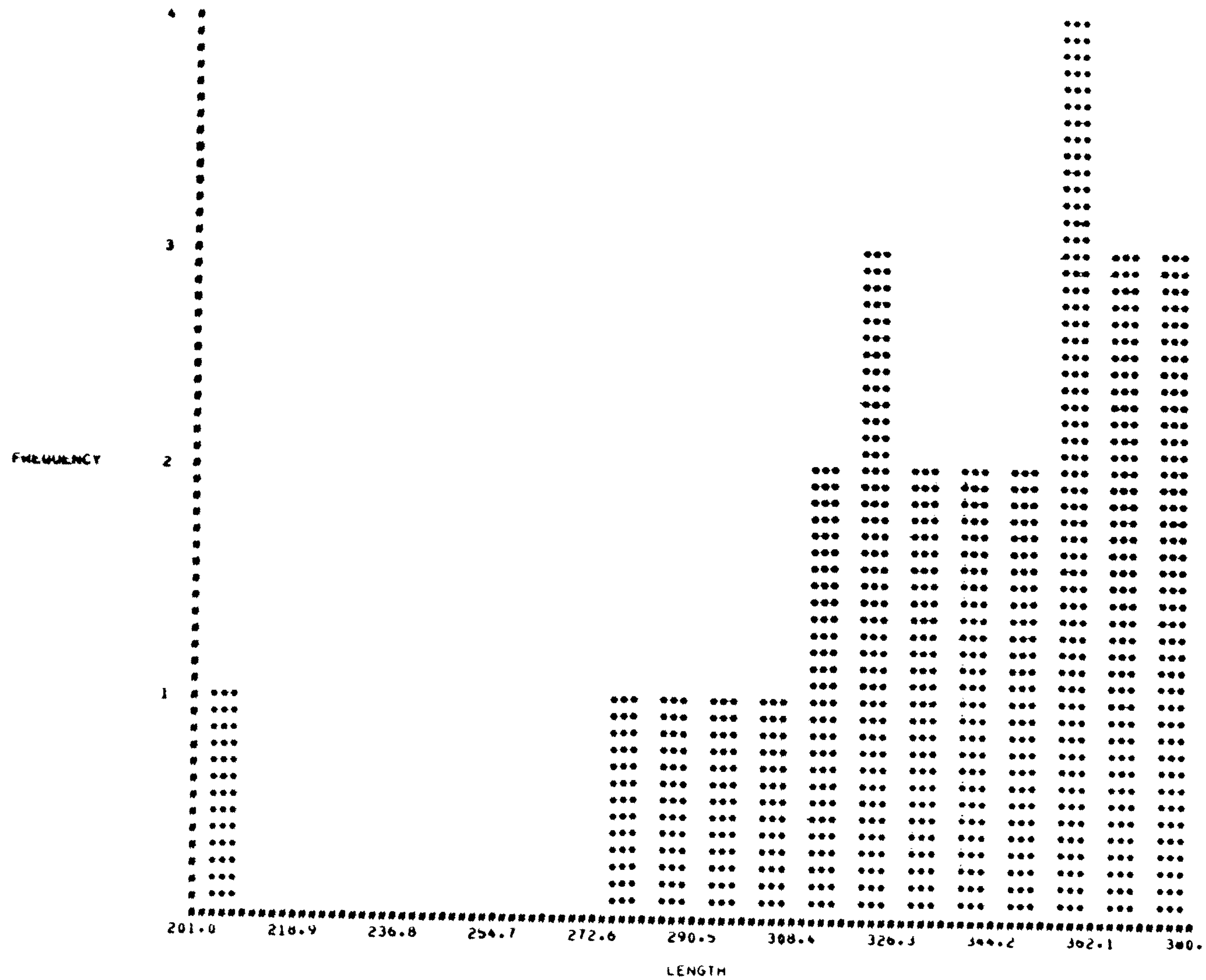

Appendix IVh. Length (mm) frequency of <u>Catostomus discobolus</u> collected at Station Y-4, 1975.



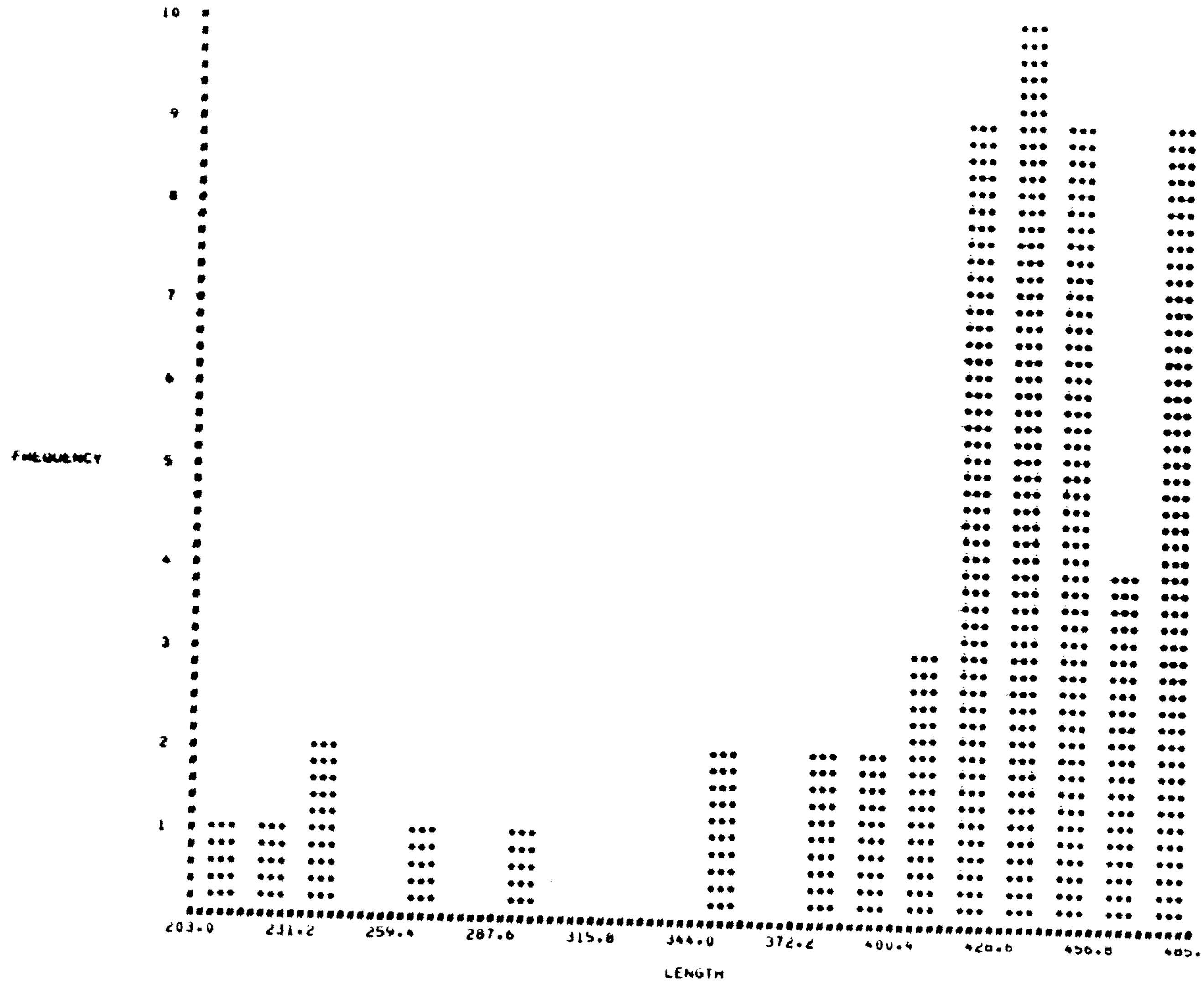
Appendix IVi. Length (mm) frequency of <u>Catostomus discobolus</u> collected at Station Y-3, 1976.



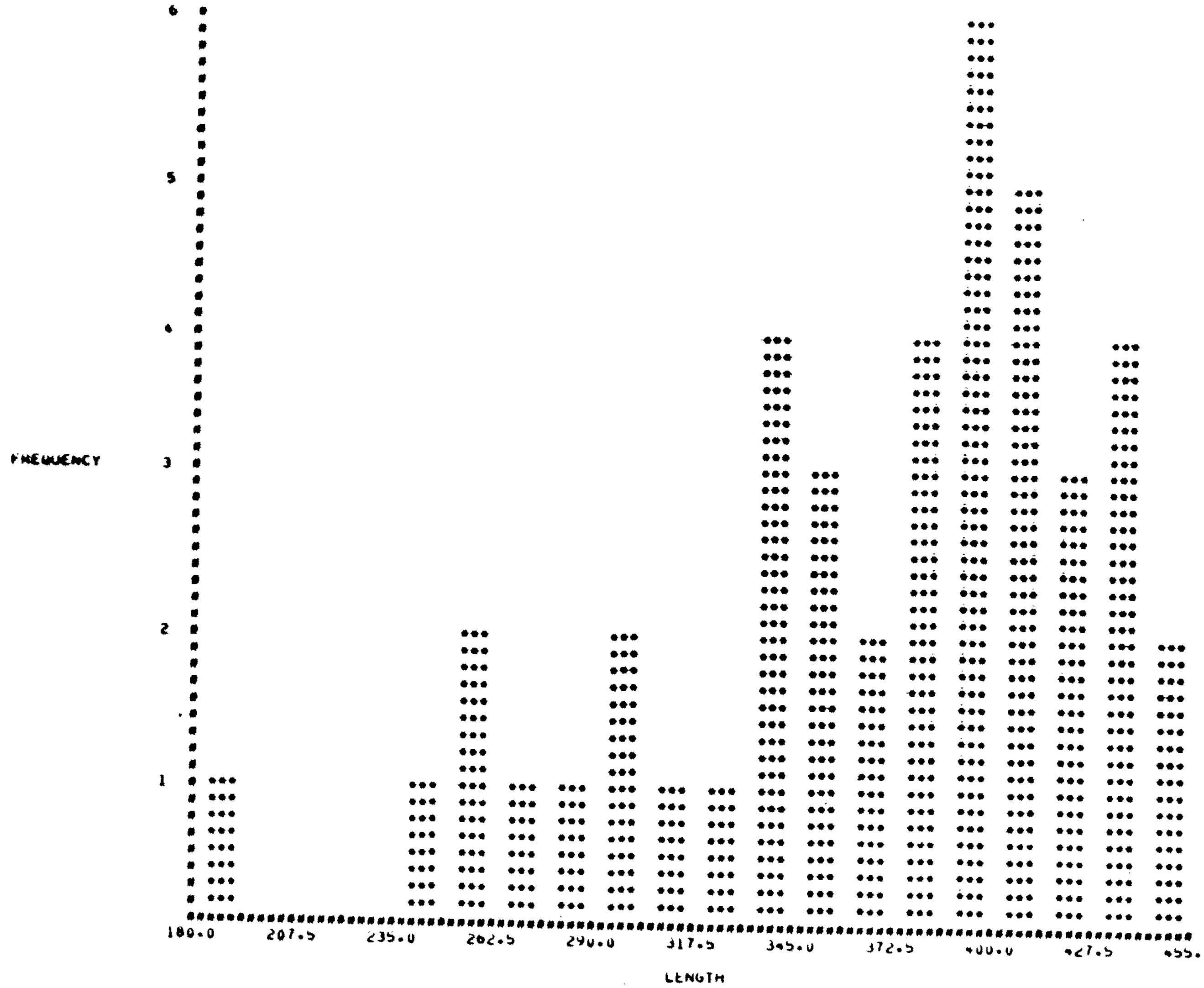
Appendix IVj. Length (mm) frequency of <u>Catostomus discobolus</u> collected at Station Y-4, 1976.



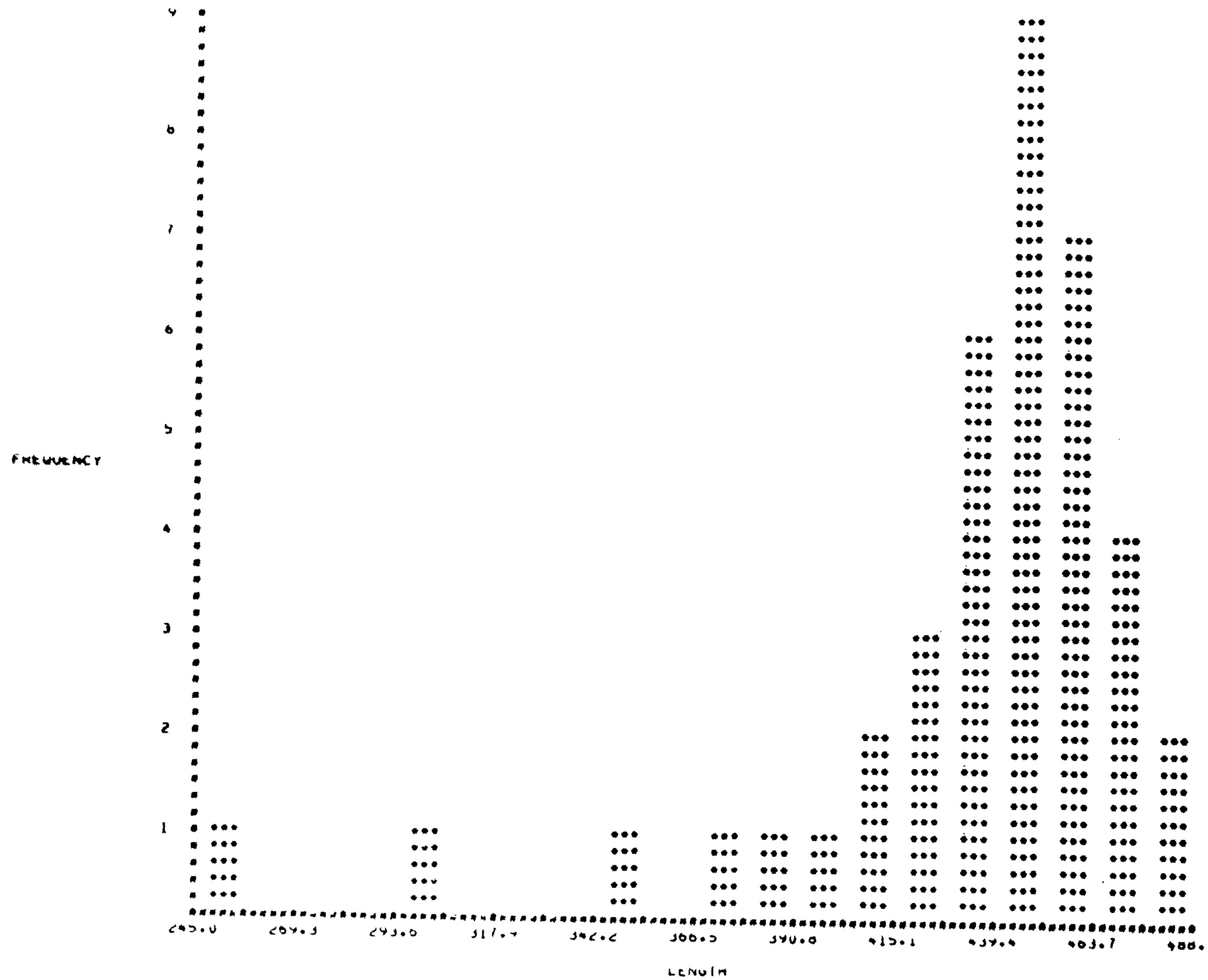

Appendix IVk. Length (mm) frequency of Catostomus discobolus collected at Station Y-3, 1977.



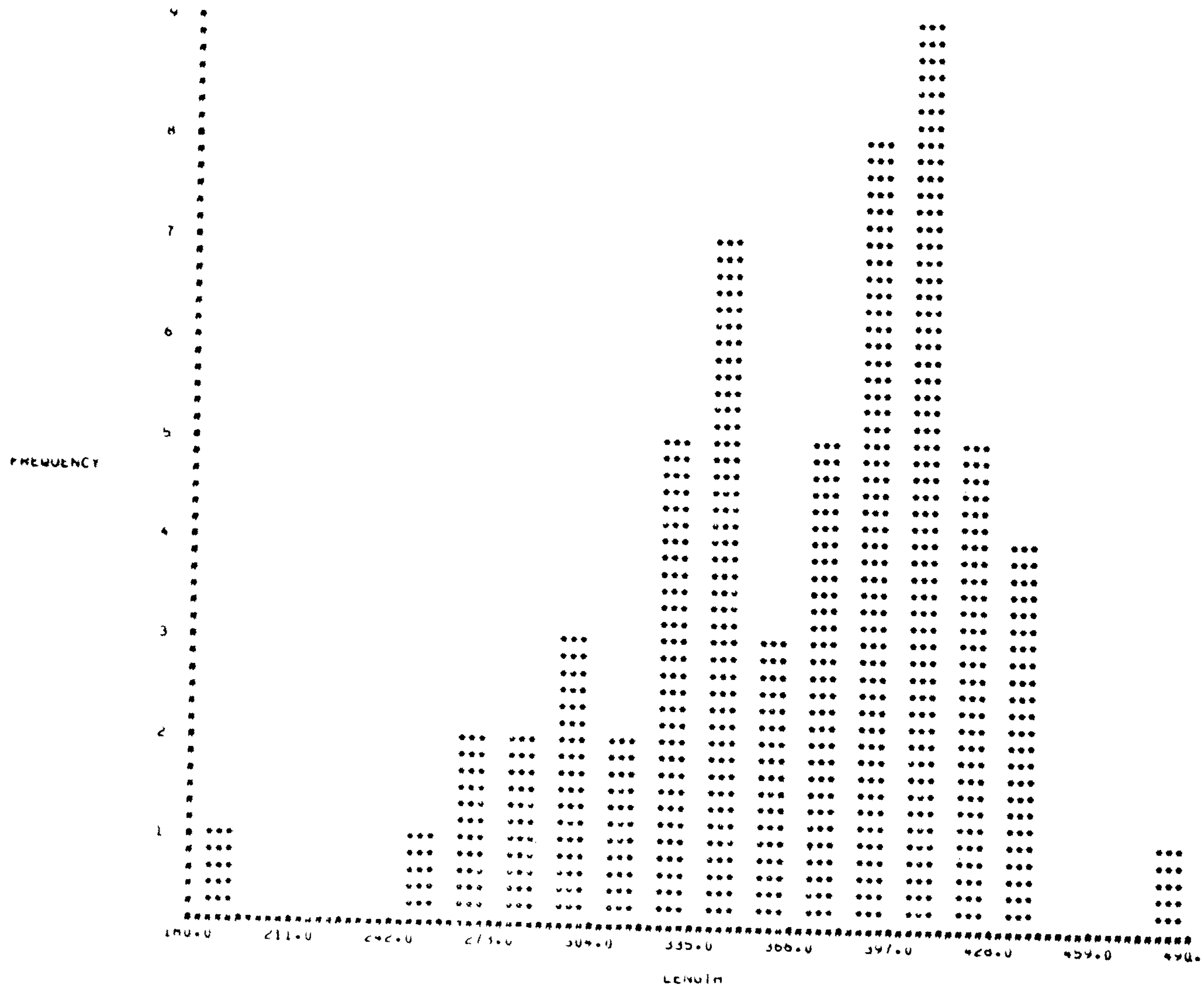

Appendix IVl. Length (mm) frequency of Catostomus latipinnis collected at Station Y-3, 1975.



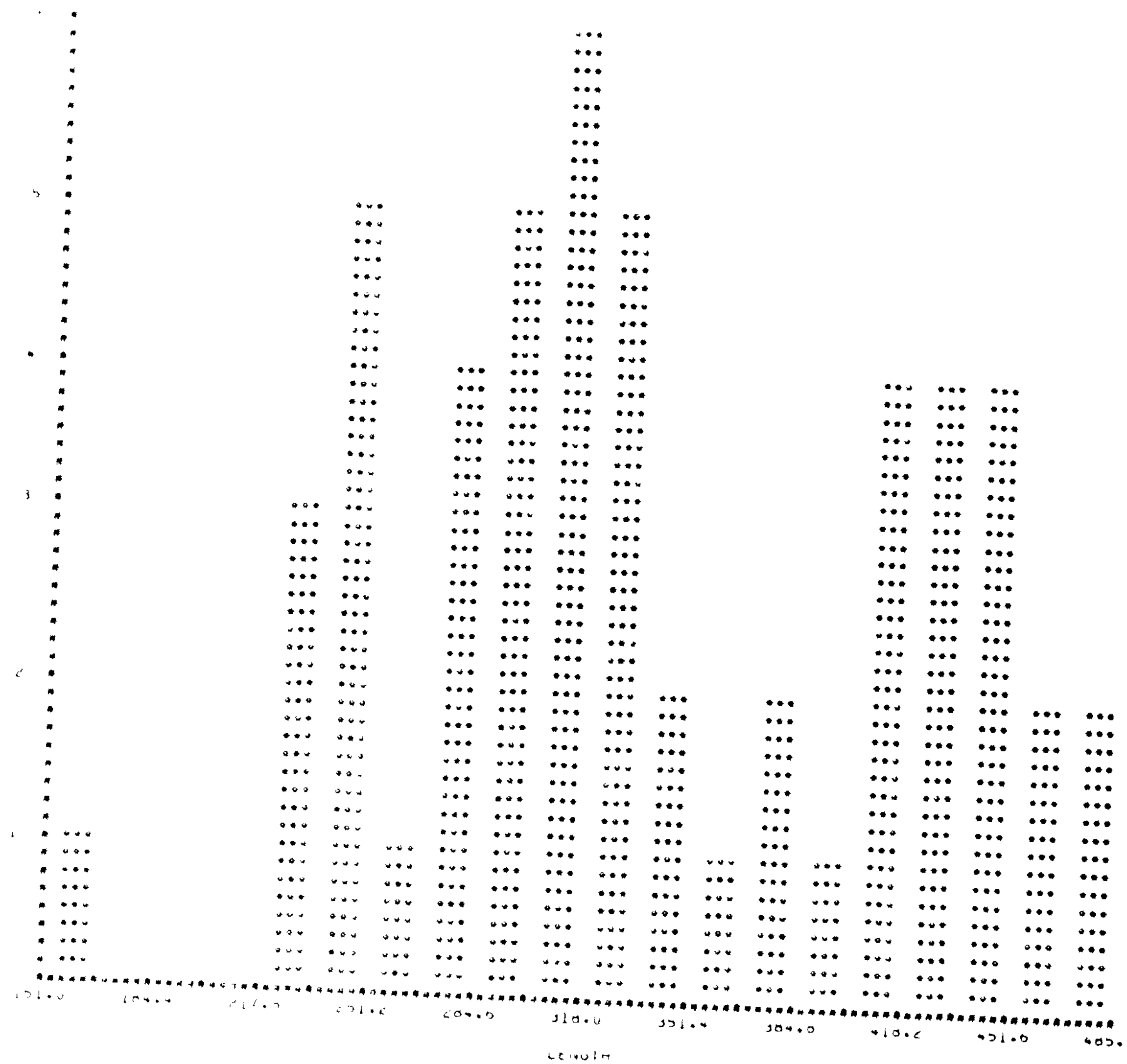

Appendix IVm. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station Y-4, 1975.



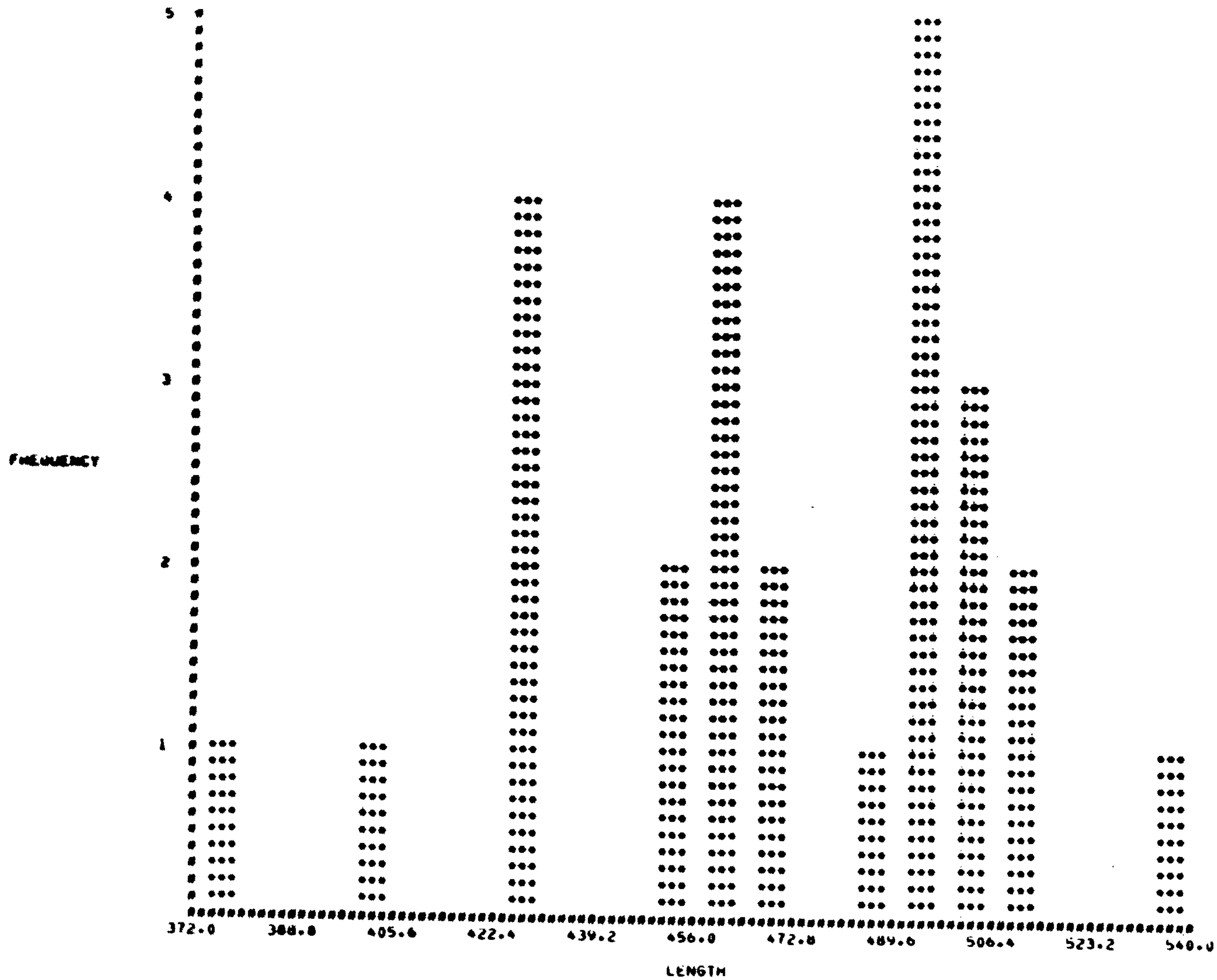

Appendix IVn. Length (mm) frequency of Catostomus latipinnis collected at Station Y-3, 1976.



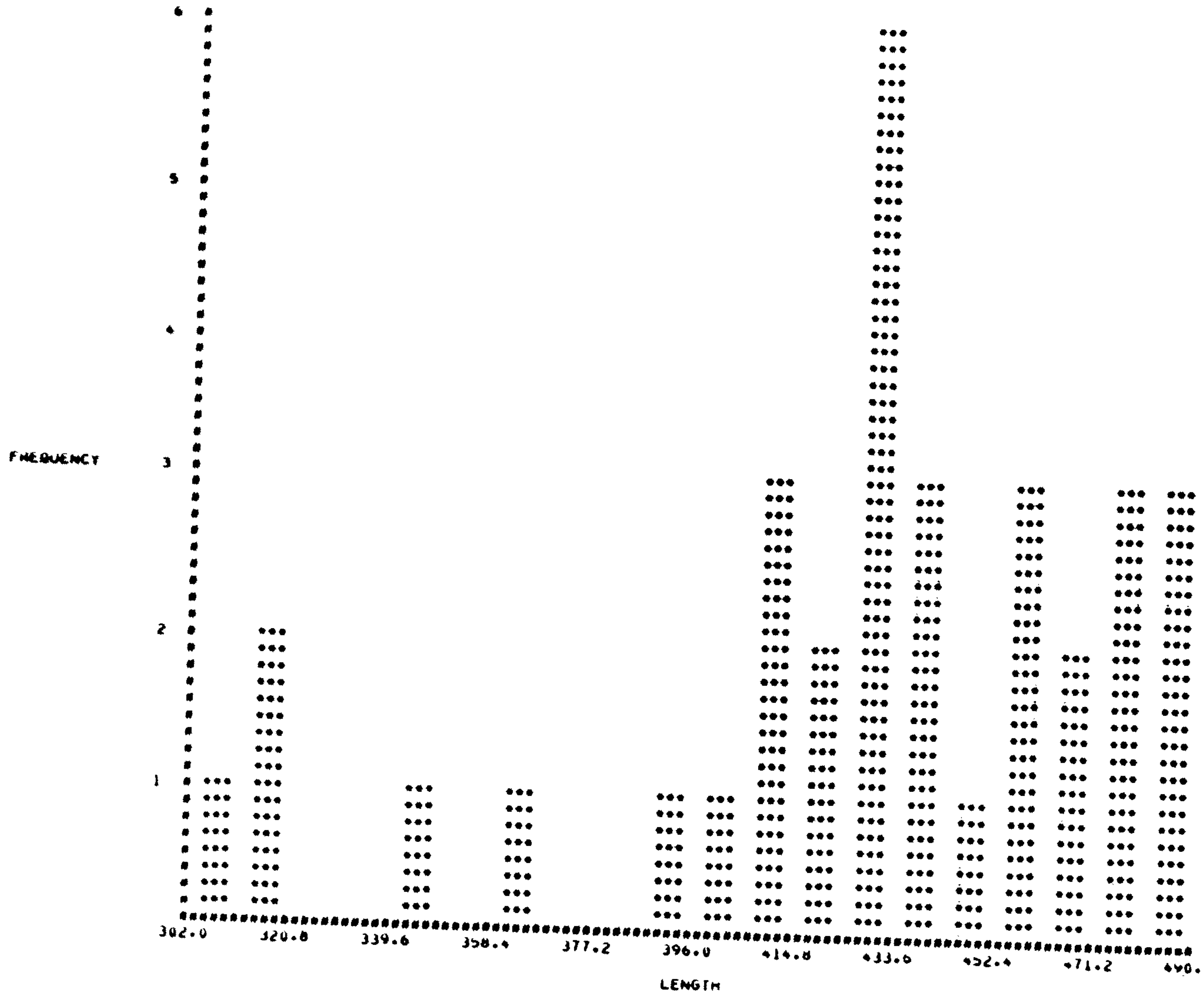

Appendix IVo. Length (mm) frequency of Catostomus latipinnis collected at Station Y-4, 1976.



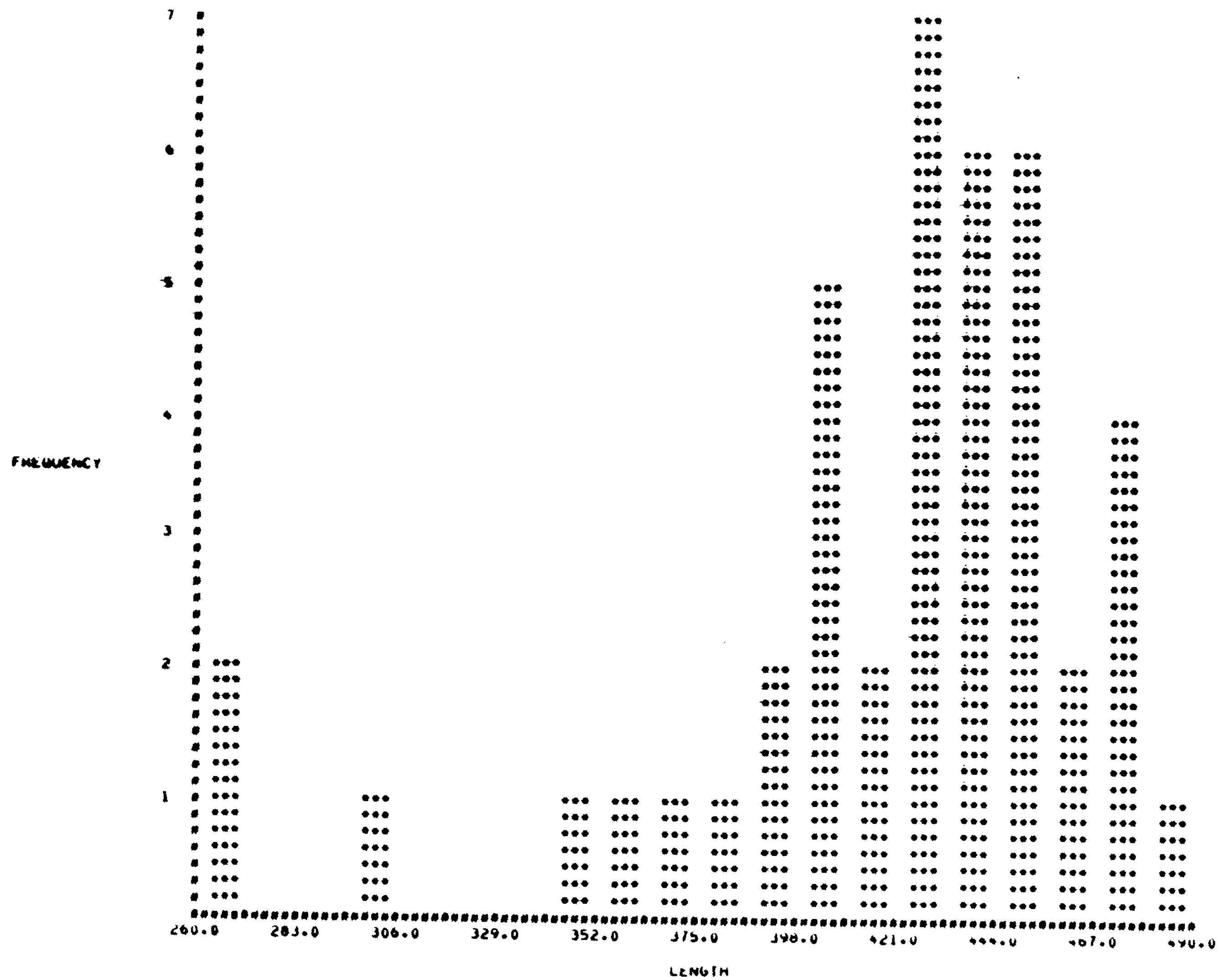
Appendix IVp. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station W-A, 1976.



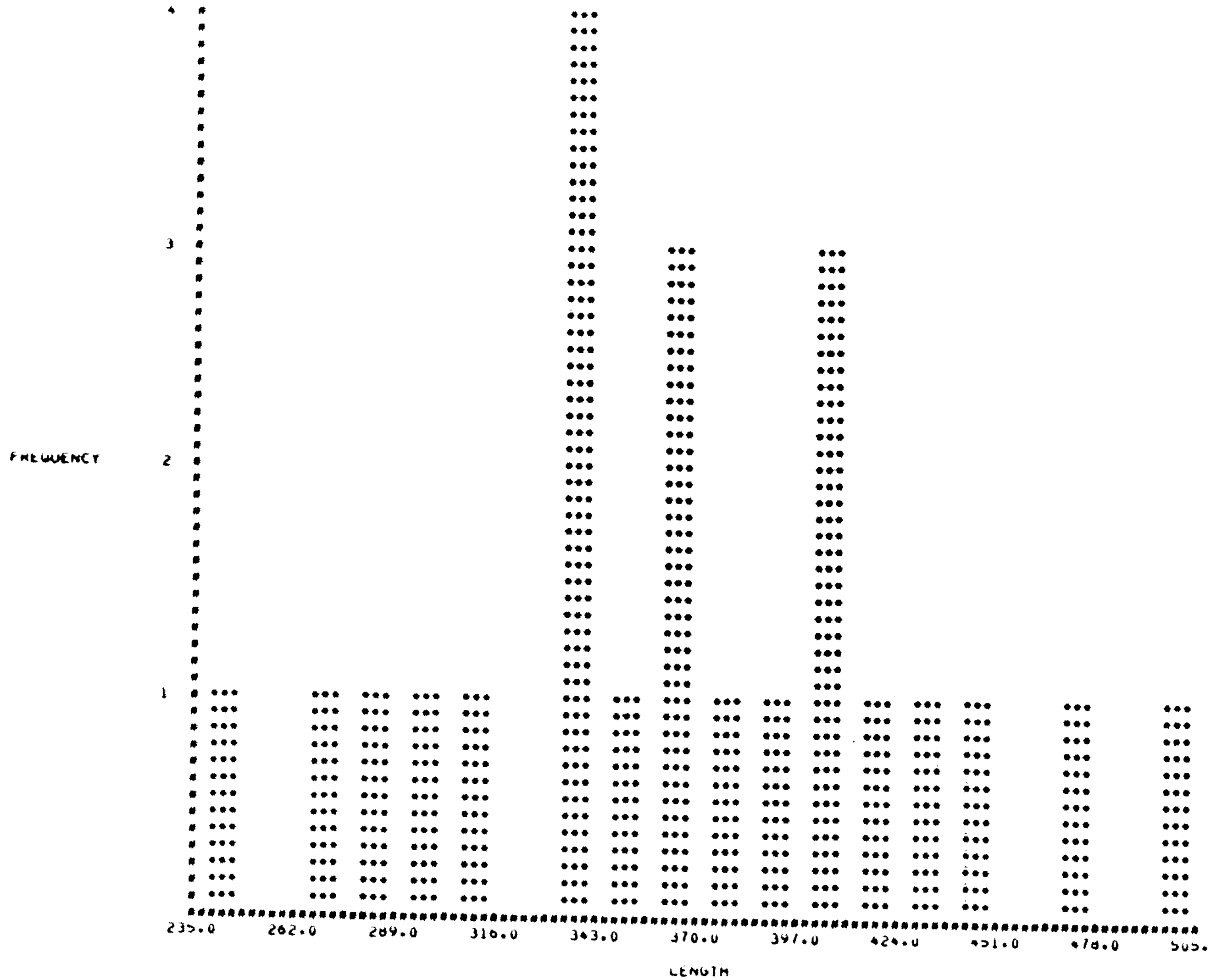

Appendix IVq. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station Y-1, 1977.



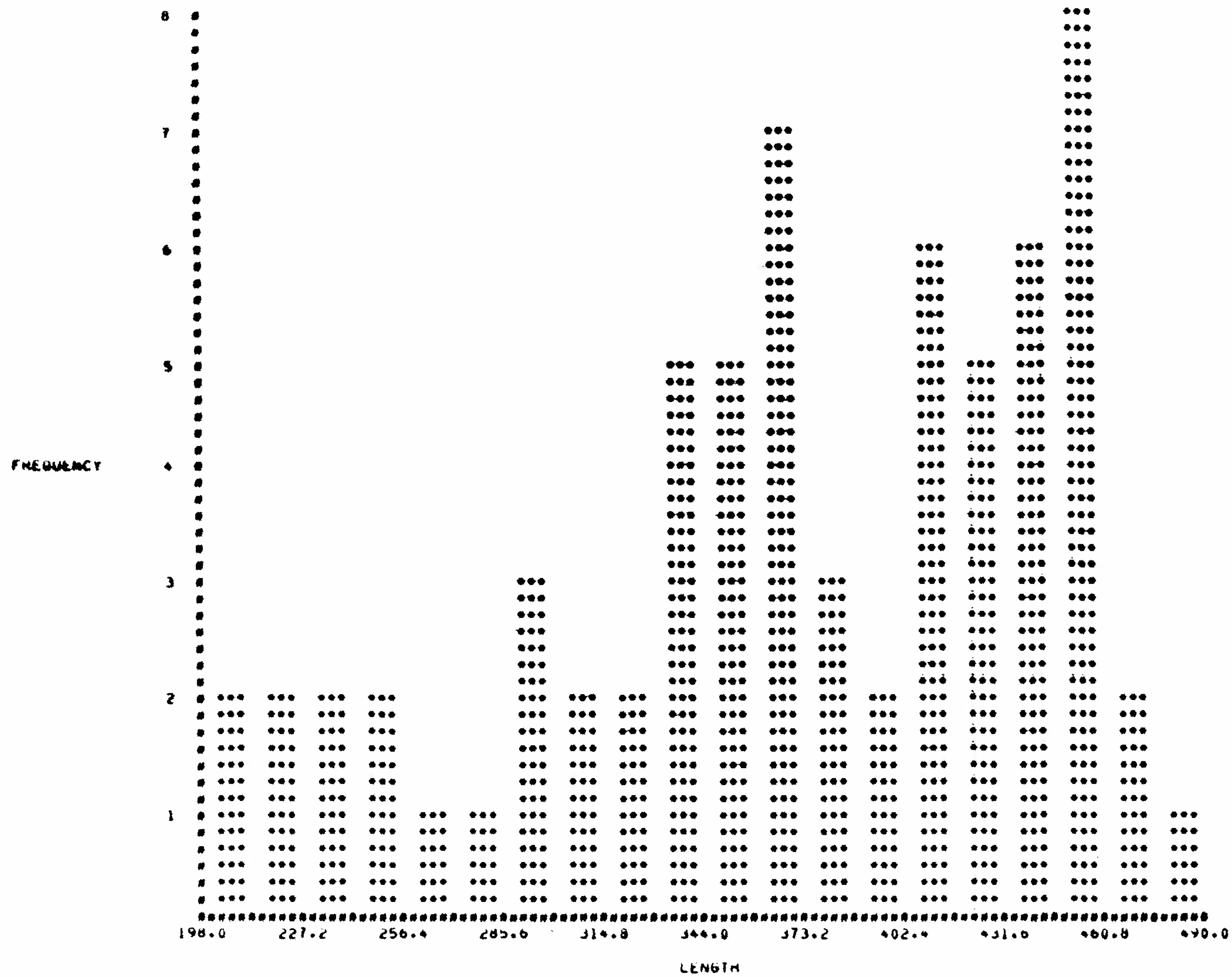

Appendix IVr. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station Y-2J, 1977



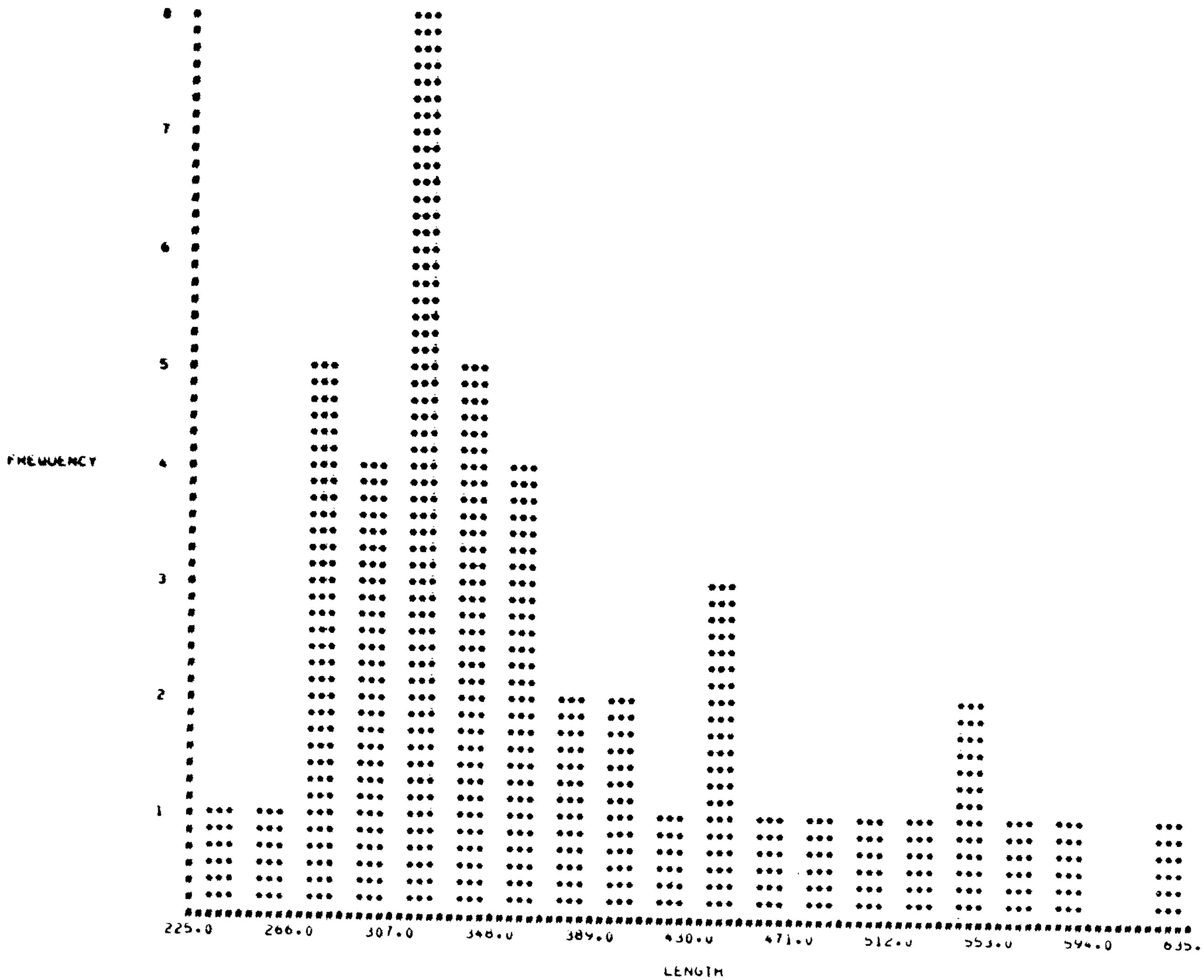

Appendix IVs. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station Y-3, 1977.



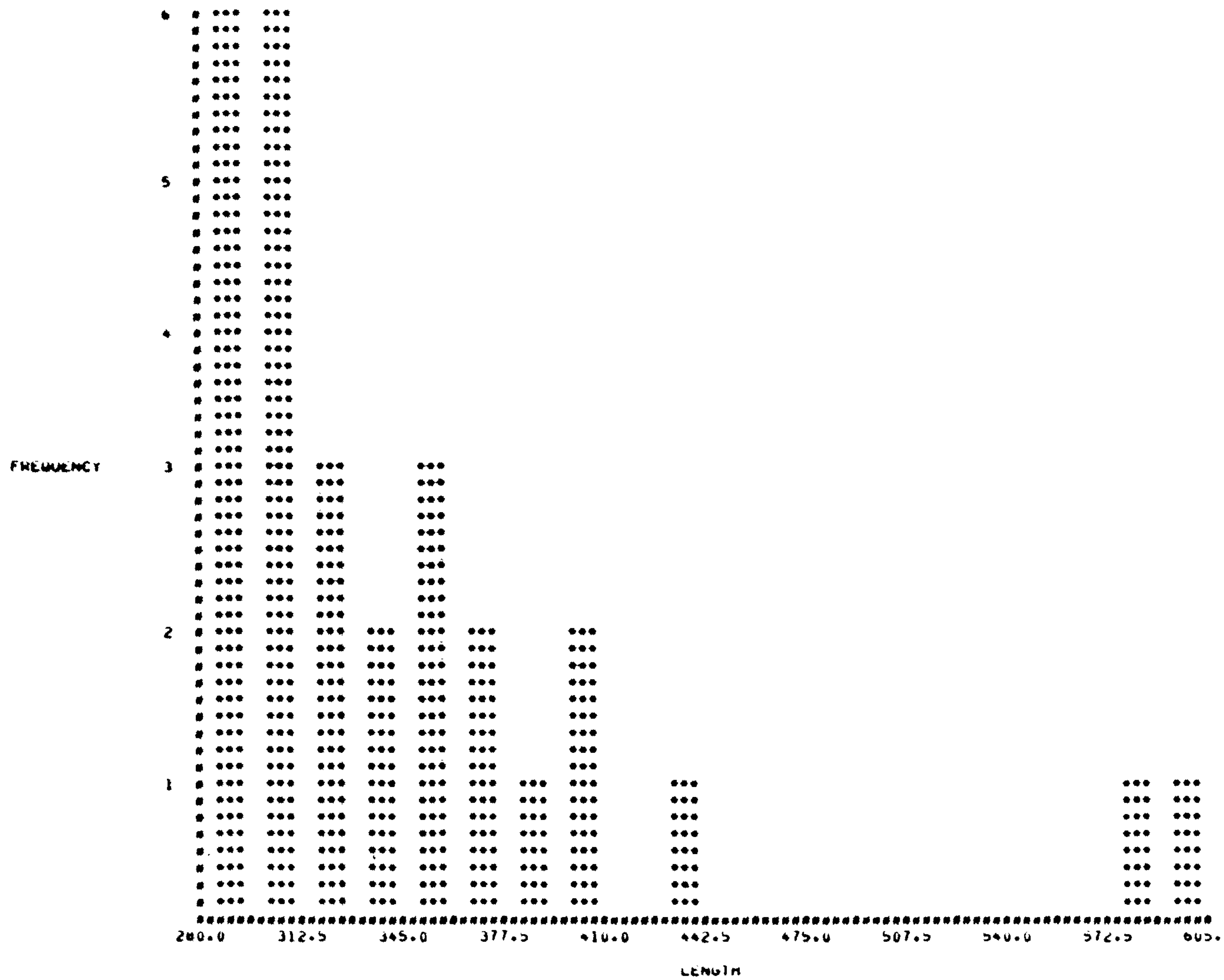

Appendix IVt. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station Y-4, 1977.




Appendix IVu. Length (mm) frequency of <u>Catostomus latipinnis</u> collected at Station W-A, 1977.




Appendix IVv. Length (mm) frequency of <u>Ictalurus punctatus</u> collected at Station Y-4, 1975.




Appendix IVw. Length (mm) frequency of <u>Ictalurus punctatus</u> collected at Station Y-4, 1977.

# APPENDIX V.

Cumulative statistics on fishes caught by electrofishing, 1975-1977, at each fish-collection station.

Cumulative statistics from years 1975-77 at Station Y-1.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 72 | 256.78 | 144.00 | 335.00 | 25.26 | .9481 |
| *Salmo gairdneri* | 8 | 208.25 | 132.00 | 292.00 | 2.81 | 1.1256 |
| *Catostomus commersoni* | 103 | 303.63 | 95.00 | 460.00 | 36.14 | 1.1749 |
| *C. discobolus* | 25 | 361.00 | 175.00 | 425.00 | 8.77 | 1.0180 |
| *C. latipinnis* | 40 | 459.30 | 360.00 | 540.00 | 14.04 | 1.0243 |
| *C. discobolus* x *latipinnis* | 1 | 315.00 | 315.00 | 315.00 | .35 | .9598 |
| *C. latipinnis* x *commersoni* | 5 | 409.00 | 330.00 | 445.00 | 1.75 | 1.1451 |
| *C. discobolus* x *commersoni* | 26 | 333.12 | 145.00 | 420.00 | 9.12 | 1.1497 |
| Unknown | 5 | 304.40 | 205.00 | 395.00 | 1.75 | 1.3058 |

Cumulative statistics from years 1975-77 at Station Y-2J.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Cyprinus carpio* | 11 | 120.64 | 78.00 | 213.00 | 15.71 | 2.1116 |
| *Gila robusta* | 2 | 328.50 | 310.00 | 347.00 | 2.86 | .8360 |
| *Ptychocheilus lucius* | 1 | 472.00 | 472.00 | 472.00 | 1.43 | 1.0252 |
| *Catostomus commersoni* | 8 | 358.88 | 152.00 | 477.00 | 11.43 | 1.1399 |
| *C. discobolus* | 7 | 341.00 | 280 00 | 375.00 | 10.00 | .8327 |
| *C. latipinnis* | 33 | 425.09 | 302.00 | 490.00 | 47.14 | 1.0501 |
| *C. discobolus* x *commersoni* | 1 | 275.00 | 275.00 | 275.00 | 1.43 | 1.0482 |
| *C. latipinnis* x *commersoni* | 7 | 465.00 | 430.00 | 500.00 | 10.00 | 1.2134 |

Cumulative statistics from years 1975-77 at Station Y-2.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 28 | 258.96 | 127.00 | 355.00 | 10.61 | 1.0236 |
| *Salmo gairdneri* | 10 | 252.40 | 218.00 | 351.00 | 3.79 | 1.0556 |
| *Cyprinus carpio* | 2 | 301.00 | 292.00 | 310.00 | .76 | 1.4929 |
| *Gila robusta* | 8 | 342.63 | 265.00 | 427.00 | 3.33 | .9234 |
| *Catostomus commersoni* | 104 | 314.90 | 101.00 | 448.00 | 39.02 | 1.1975 |
| *C. discobolus* | 22 | 313.23 | 140.00 | 398.00 | 8.33 | 1.1372 |
| *C. latipinnis* | 45 | 419.31 | 255.00 | 541.00 | 17.05 | 1.0150 |
| *C. discobolus* x *latipinnis* | 2 | 405.00 | 395.00 | 415.00 | .76 | 1.0134 |
| *C. latipinnis* x *commersoni* | 19 | 351.26 | 200.00 | 512.00 | 7.20 | 1.0705 |
| *C. discobolus* x *commersoni* | 24 | 331.21 | 222.00 | 434.00 | 9.09 | 1.0941 |

Cumulative statistics from years 1975-77 at Station Y-3.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 1 | 156.00 | 156.00 | 156.00 | .39 | .7902 |
| *Salmo gairdneri* | 1 | 442.00 | 442.00 | 442.00 | .39 | .9033 |
| *Cyprinus carpio* | 11 | 479.36 | 330.00 | 736.00 | 4.28 | 1.5778 |
| *Gila robusta* | 13 | 259.15 | 147.00 | 385.00 | 5.05 | .9006 |
| *Ptychocheilus lucius* | 3 | 515.60 | 433.00 | 635.00 | 1.17 | .8670 |
| *Catostomus commersoni* | 20 | 288.50 | 135.00 | 480.00 | 7.78 | 1.1506 |
| *C. latipinnis* x *commersoni* | 11 | 395.82 | 182.00 | 497.00 | 4.28 | 1.1645 |
| *C. discobolus* | 55 | 318.91 | 89.00 | 380.00 | 21.40 | 1.0778 |
| *C. latipinnis* | 137 | 421.09 | 203.00 | 490.00 | 53.50 | .9772 |
| *C. discobolus* x *latipinnis* | 2 | 318.50 | 231.00 | 406.00 | .78 | .9587 |

Cumulative statistics from years 1975-77 at Station Y-3 (continued).

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *C. discobolus* x *commersoni* | 1 | 350.00 | 350.00 | 350.00 | .39 | .9096 |
| *Ictalurus punctatus* | 2 | 412.50 | 260.00 | 565.00 | .78 | .8896 |

Cumulative statistics from years 1975-77 at Station Y-4A.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Cyprinus carpio* | 2 | 342.50 | 330.00 | 355.00 | 5.72 | 1.2047 |
| *Gila robusta* | 5 | 211.40 | 130.00 | 315.00 | 14.29 | .6704 |
| *Ptychocheilus lucius* | 3 | | | | 8.57 | |
| *Catostomus commersoni* | 1 | 195.00 | 195.00 | 195.00 | 2.86 | 1.0789 |
| *C. discobolus* | 3 | 299.00 | 218.00 | 342.00 | 8.57 | .6976 |
| *C. latipinnis* | 19 | 336.37 | 177.00 | 452.00 | 54.29 | .7884 |
| *Ictalurus punctatus* | 2 | 301.50 | 292.00 | 311.00 | 5.72 | .8338 |

Cumulative statistics from years 1975-77 at Station Y-4.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Salmo trutta* | 1 | 280.00 | 280.00 | 280.00 | .26 | 1.1844 |
| *Cyprinus carpio* | 40 | 405.73 | 290.00 | 570.00 | 10.58 | 1.3434 |
| *Gila robusta* | 24 | 286.46 | 144.00 | 390.00 | 6.35 | .8157 |
| *Catostomus commersoni* | 2 | 191.50 | 126.00 | 257.00 | .53 | 1.2654 |
| *C. discobolus* | 106 | 312.92 | 176.00 | 400.00 | 28.04 | .8405 |
| *C. latipinnis* | 124 | 364.45 | 180.00 | 505.00 | 32.80 | .9127 |
| *Ictalurus punctatus* | 81 | 364.81 | 225.00 | 635.00 | 21.43 | .8884 |

Cumulative statistics from years 1975-77 at Station W-A.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| *Prosopium williamsoni* | 24 | 250.71 | 134.00 | 354.00 | 13.40 | .8392 |
| *Cyprinus carpio* | 5 | 502.40 | 455.00 | 532.00 | 2.79 | 1.6160 |
| *Gila robusta* | 10 | 317.40 | 258.00 | 412.00 | 5.59 | .8705 |
| *Ptychocheilus lucius* | 2 | | | | 1.12 | |
| *C. discobolus* | 14 | 339.00 | 209.00 | 430.00 | 7.82 | .9400 |
| *C. latipinnis* | 119 | 355.12 | 151.00 | 490.00 | 66.48 | .9321 |
| *C. discobolus* x *latipinnis* | 2 | 320.50 | 319.00 | 322.00 | 1.12 | .7992 |
| *Ictalurus punctatus* | 2 | 405.50 | 390.00 | 421.00 | 1.12 | .9426 |
| *I. melas* | 1 | 240.00 | 240.00 | 240.00 | .56 | 1.3889 |

Cumulative statistics from years 1975-77 at Station W-B.

| SPECIES | n | Average Length | Range of Length | | % Composition | Average K |
|---|---|---|---|---|---|---|
| Cyprinus carpio | 4 | 469.00 | 390.00 | 557.00 | 3.13 | 1.2856 |
| Gila robusta | 20 | 256.60 | 161.00 | 400.00 | 15.63 | .8297 |
| C. discobolus | 7 | 254.86 | 130.00 | 416.00 | 5.47 | 1.0231 |
| C. latipinnis | 96 | 337.11 | 108.00 | 486.00 | 75.00 | .8942 |
| Ictalurus punctatus | 1 | 390.00 | 390.00 | 390.00 | .78 | .6575 |

## APPENDIX VI.

Total numbers of organisms for all insect taxa collected on the Yampa and White Rivers, Colorado, July 1975 to October 1976.

Appendix VI. Total number of organisms for all insect taxa collected on the Yampa and White Rivers, Colorado, July 1975 to October 1976.

| Taxon | Yampa | White |
|---|---|---|
| EPHEMEROPTERA | | |
| Ephemerellidae | | |
| *Ephemerella inermis* | 25,611 | 19,378 |
| *E. hecuba* | 4 | 1 |
| *E. grandis* | 106 | 209 |
| *E. doddsi* | 0 | 1 |
| *E. margarita* | 0 | 5 |
| Baetidae | | |
| *Baetis* sp. | 7,391 | 9,398 |
| *Pseudocloeon* sp. | 7 | 18 |
| *Centroptilum* sp. | 0 | 2 |
| Heptageniidae | | |
| *Rhithrogena* sp. | 7,115 | 2,459 |
| *Heptagenia* sp. | 358 | 581 |
| *Epeorus* sp. | 15 | 11 |
| Tricorythidae | | |
| *Tricorythodes minutus* | 13,821 | 12,229 |
| Ephemeridae | | |
| *Ephemera simulans* | 183 | 1 |
| Leptophlebiidae | | |
| *Paraleptophlebia* sp. A | 563 | 36 |
| *Paraleptophlebia* sp. B | 22 | 0 |
| *Traverella albertana* | 135 | 911 |
| *Leptophlebia* sp. | 189 | 0 |
| *Choroterpes albiannulata* | 2,312 | 2,263 |
| Polymitarcidae | | |
| *Ephoron album* | 706 | 15 |
| Siphlonuridae | | |
| *Isonychia* sp. | 0 | 1 |
| *Ameletus* sp. | 36 | 3 |

Appendix VI (Continued).

| Taxon | Yampa | White |
|---|---|---|
| Ametropidae | | |
| *Ametropus albrighti* | 1 | 0 |
| Caenidae | | |
| *Caenis* sp. | 1 | 4 |
| *Brachycercus* sp. | 3 | 1 |
| Oligonuridae | | |
| *Lachlania saskatchewanensis* | 1 | 10 |
| TRICOPTERA | | |
| Hydropsychidae | | |
| *Hydropsyche* sp. | 5,685 | 7,532 |
| *Cheumatopsyche* sp. | 9,339 | 3,547 |
| *Arctopsyche* sp. | 28 | 136 |
| Brachycentridae | | |
| *Brachycentrus* sp. | 84 | 45 |
| Leptoceridae | | |
| *Oecetis* sp. | 2,401 | 56 |
| *Triaenodes* sp. | 126 | 1 |
| Hydroptilidae | | |
| *Hydroptila* sp. | 598 | 661 |
| *Orthotrichia* sp. | 2 | 0 |
| *Agraylea* sp. | 1 | 1 |
| *Mayatrichia* sp. | 4 | 196 |
| *Leucotrichia* sp. | 41 | 4 |
| *Neotrichia* sp. | 8 | 0 |
| *Ochrotrichia* sp. | 2 | 0 |
| Limnephilidae | | |
| *Drusinus* sp. | 1 | 0 |
| *Platycentropus* sp. | 1 | 0 |
| *Hesperophylax* sp. | 1 | 1 |
| Lepidostomatidae | | |
| *Lepidostoma* sp. | 216 | 193 |

Appendix VI (Continued).

| Taxon | Yampa | White |
| --- | --- | --- |
| Glossosomatidae | | |
| *Protoptila* sp. | 530 | 33 |
| *Glossosoma* sp. | 0 | 1 |
| Helicopsychidae | | |
| *Helicopsyche* sp. | 284 | 0 |
| Psychomyidae | | |
| *Psychomyia* sp. | 208 | 19 |
| *Neureclipsis* sp. | 6 | 0 |
| *Polycentropus* sp. | 4 | 0 |
| PLECOPTERA | | |
| Perlodidae | | |
| *Isoperla* sp. | 2,075 | 1,581 |
| *Isogenus* sp. | 618 | 272 |
| *Arcynopteryx* sp. | 25 | 0 |
| Perlidae | | |
| *Claassenia sabulosa* | 628 | 11 |
| *Acroneuria* sp. | 1 | 0 |
| Chloroperlidae | | |
| *Alloperla* sp. | 423 | 44 |
| Pteronarcidae | | |
| *Pteronarcys californica* | 50 | 37 |
| *Pteronarcella badia* | 337 | 5 |
| Nemouridae | | |
| *Nemoura* sp. | 14 | 1 |
| *Brachyptera* sp. | 351 | 135 |
| *Capnia* sp. | 677 | 42 |
| LEPIDOPTERA | | |
| Pyralidae | | |
| *Cataclysta* sp. | 69 | 332 |

Appendix VI (Continued).

| Taxon | Yampa | White |
| --- | --- | --- |
| DIPTERA | | |
| Rhagionidae | | |
| *Atherix variegata* | 1,874 | 209 |
| Simuliidae | | |
| larvae | 2,092 | 2,064 |
| pupae: | | |
| *Simulium venustum* | 7 | 0 |
| *S. virgatum* | 1 | 0 |
| *S. bivittatum* | 37 | 117 |
| *S. arcticum* | 66 | 302 |
| *S. vittatum* | 8 | 0 |
| Tipulidae | | |
| *Tipula* sp. | 2 | 1 |
| *Hexatoma* sp. | 948 | 953 |
| *Ormosia* sp. | 1 | 0 |
| *Holorusia* sp. | 0 | 1 |
| Empididae | | |
| pupae | 15 | 19 |
| Ceratopogonidae | | |
| *Palpomyia* sp. | 66 | 7 |
| Deuterophlebiidae | | |
| pupae | 1 | 0 |
| Tanyderidae | | |
| *Protanyderus* sp. | 1 | 0 |
| Ephydridae | 1 | 1 |
| Stratiomyidae | | |
| *Stratiomys* sp. | 0 | 1 |
| Blepharoceridae | 1 | 0 |
| Psychodidae | | |
| *Pericoma* sp. | 2 | 0 |

Appendix VI (Continued).

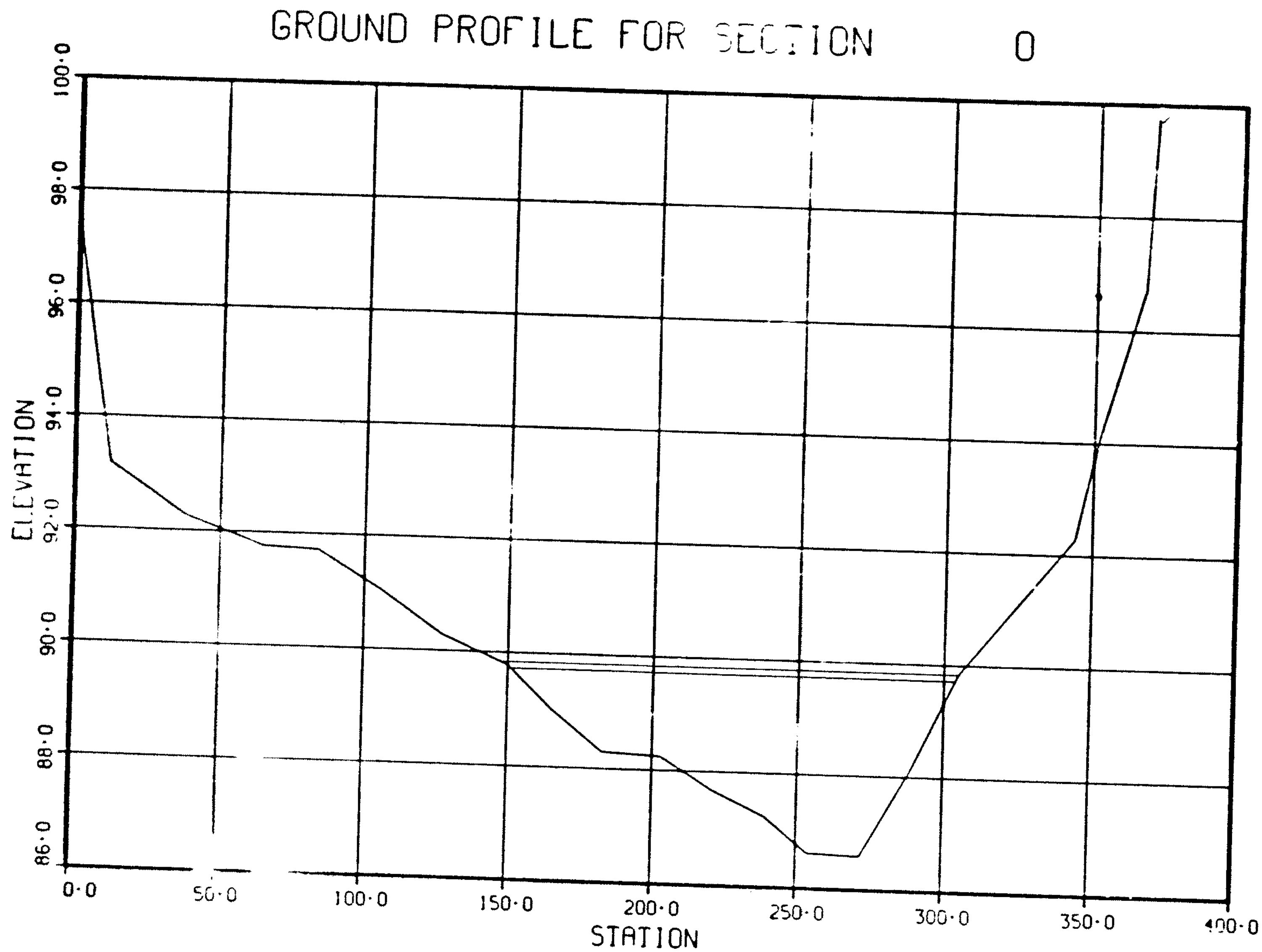
| Taxon | Yampa | White |
|---|---|---|
| Dolichopodidae | 1 | 0 |
| Chironomidae | 13,973 | 5,038 |
| COLEOPTERA | | |
| Elmidae | | |
| *Microcylleopis* sp. | 116 | 334 |
| *Zaitzevia* sp. | 810 | 126 |
| *Dubiraphia* sp. | 387 | 18 |
| *Optioservus* sp. | 598 | 26 |
| Haliplidae | | |
| *Haliplus* sp. | 2 | 1 |
| *Brychius* sp. | 0 | 2 |
| Dytiscidae | | |
| *Laccodytes* sp. | 1 | 0 |
| *Eretes* sp. | 1 | 0 |
| *Derovatellus* sp. | 2 | 0 |
| *Hydrovatus* sp. | 1 | 0 |
| Hydraenidae | | |
| *Ochthebius* sp. | 1 | 0 |
| Dryopidae | | |
| *Dryops* sp. | 1 | 0 |
| Hydrophilidae | | |
| *Heophorus* sp. | 2 | 0 |
| HEMIPTERA | | |
| Corixidae | 831 | 181 |
| Veliidae | | |
| *Rhagovelia* sp. | 104 | 51 |
| Naucoridae | | |
| *Ambrysus mormon* | 18 | 3 |

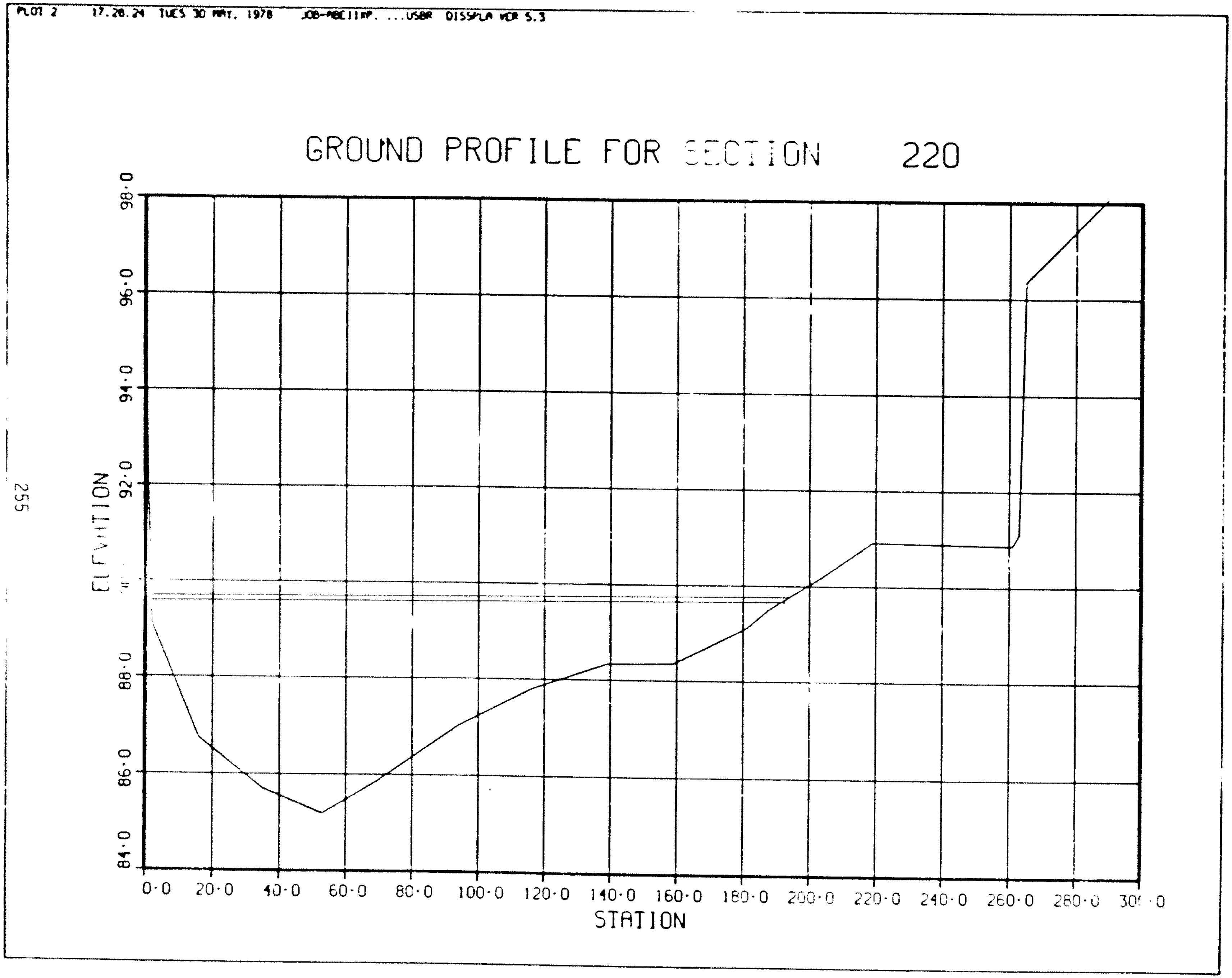
Appendix VI (Continued).

| Taxon | Yampa | White |
|---|---|---|
| ODONATA | | |
| Gomphidae | | |
| *Ophiogomphus* sp. | 82 | 134 |

APPENDIX VIIa.

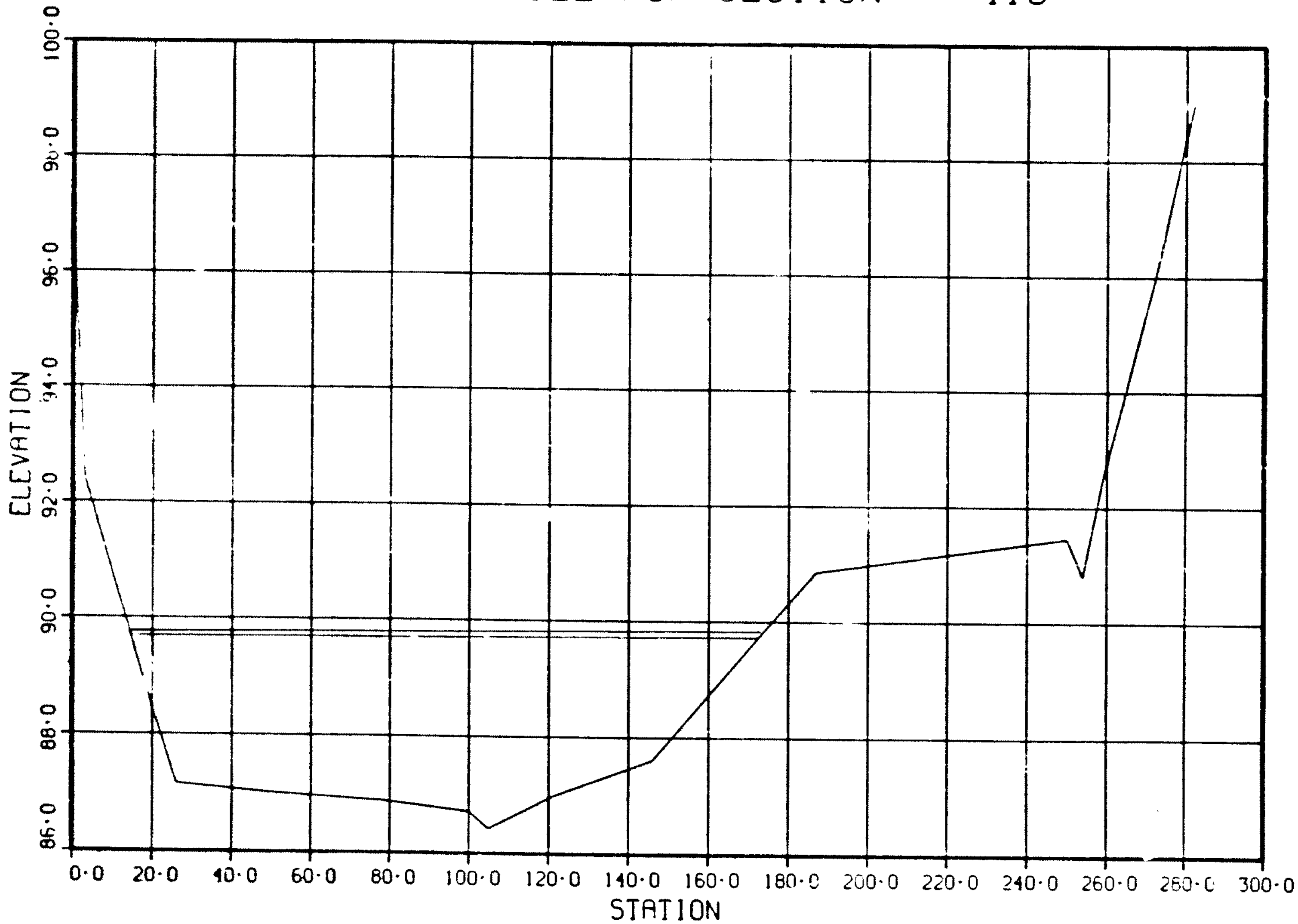
Ground profiles of cross-sections 0-727 at Station Y-3.
Double lines indicate water surface elevation at 100 cfs.

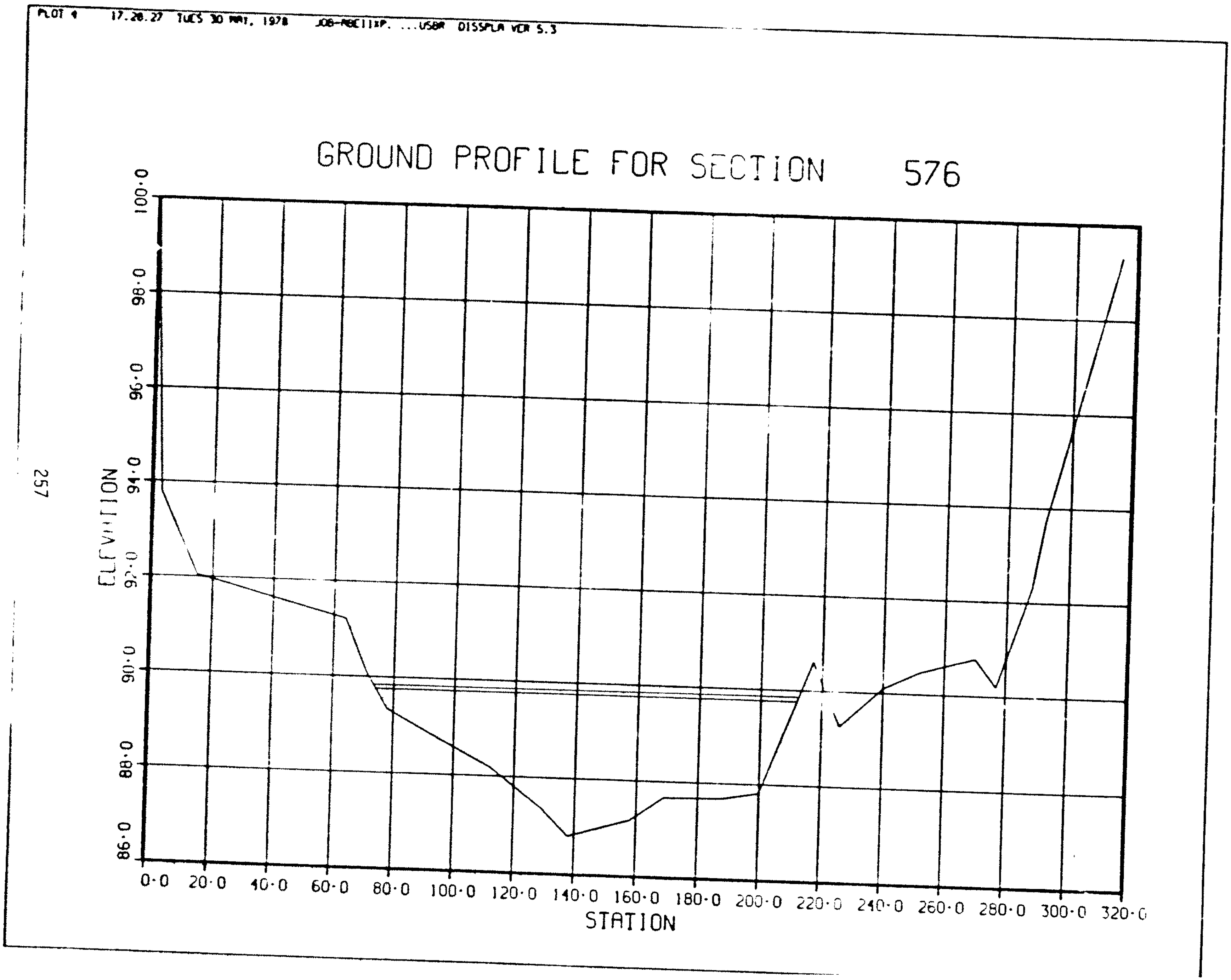

GROUND PROFILE FOR SECTION 0
ELEVATION
100·0
98·0
96·0
94·0
92·0
90·0
88·0
86·0
0·0
50·0
100·0
150·0
200·0
250·0
300·0
350·0
400·0
STATION


PLOT 2 17.28.24 TUES 30 MAY, 1978 JOB-ABC11XP. ...USBR DISSPLA VER 5.3
GROUND PROFILE FOR SECTION 220
ELEVATION
98.0
96.0
94.0
92.0
88.0
86.0
84.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
STATION

PLOT 3 17.20.25 TUES 30 MAY, 1978 JOB-ABC11XP. ...USBR DISSPLA VER 5.3

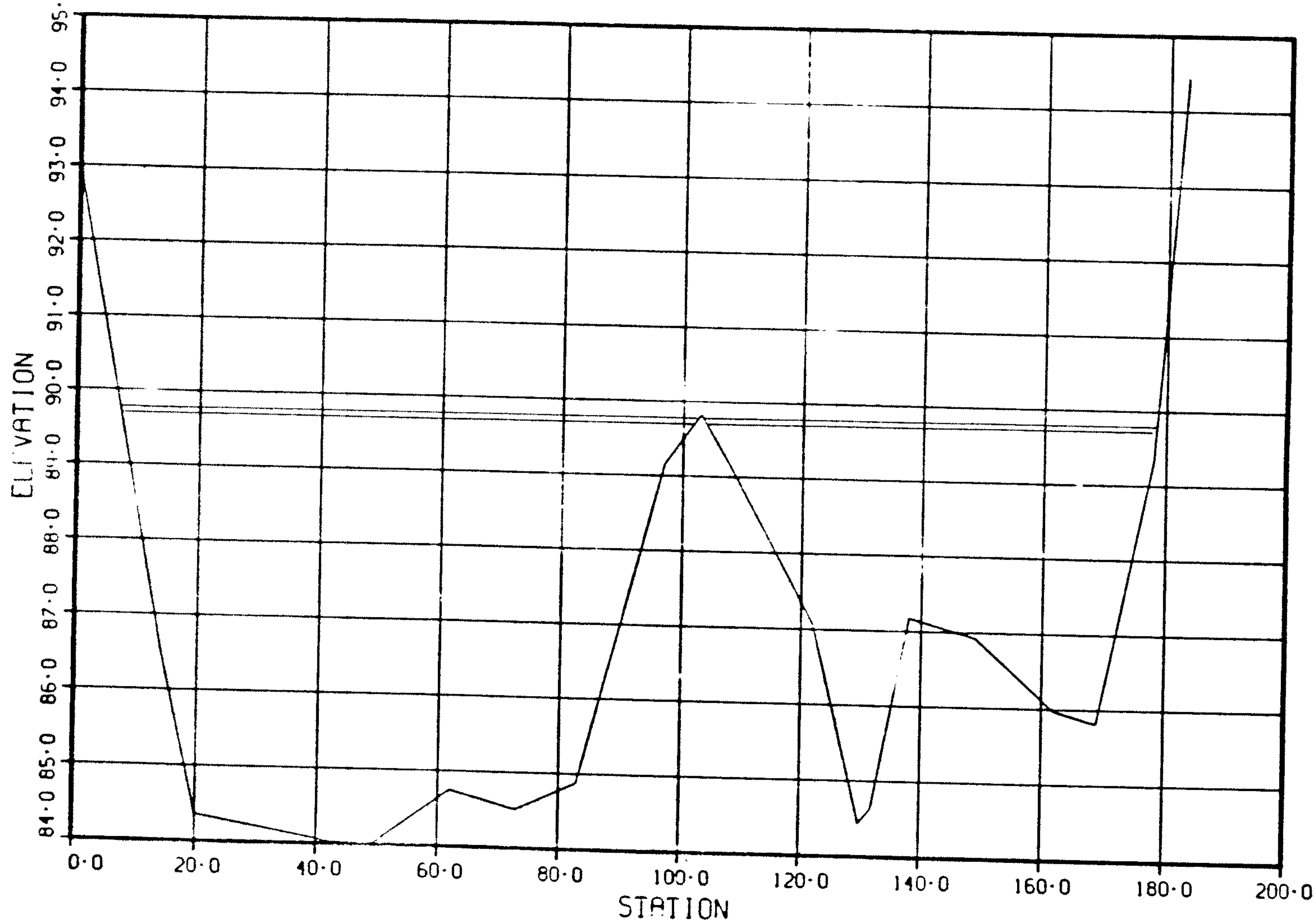
GROUND PROFILE FOR SECTION 419





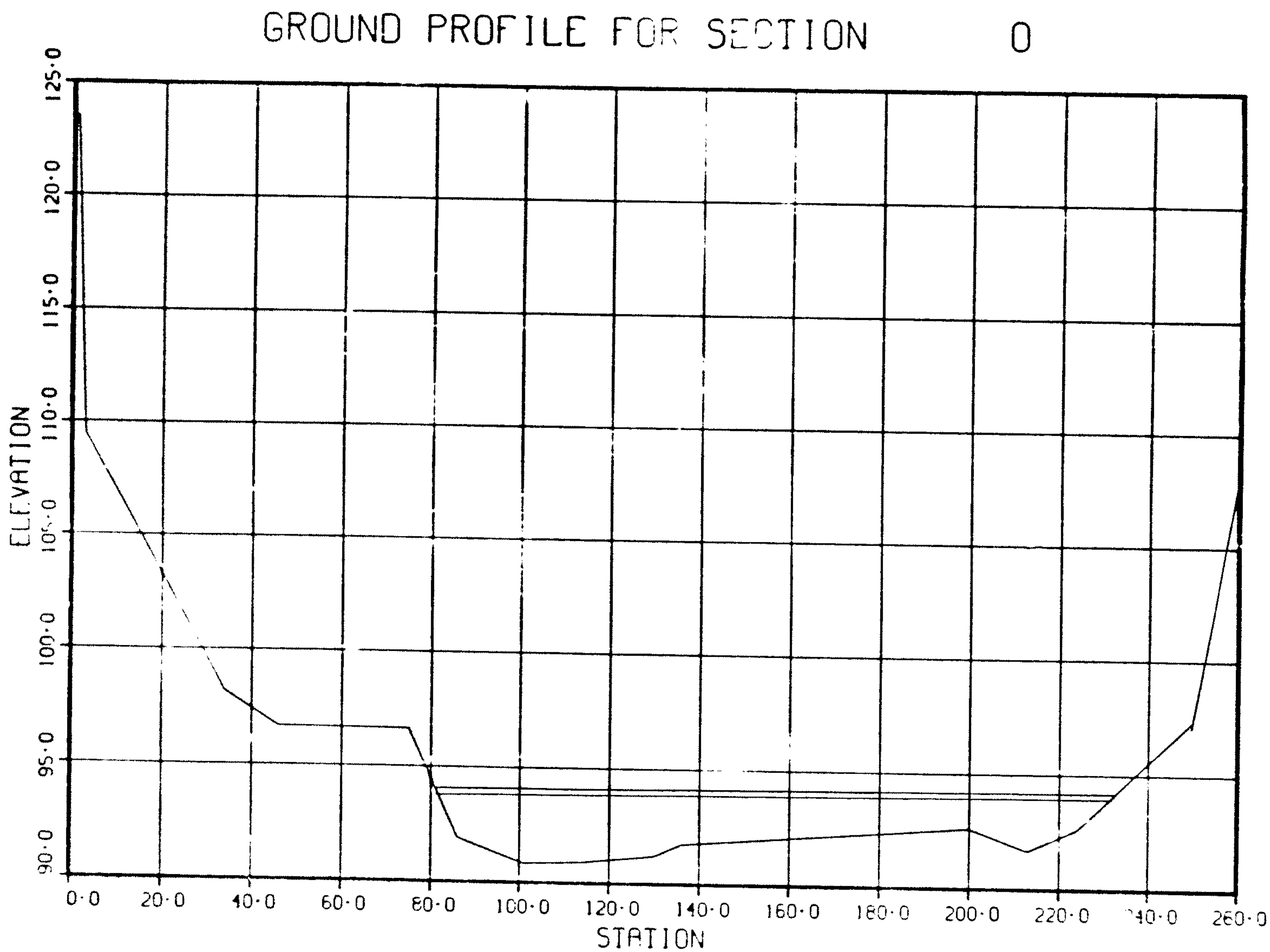
PLOT 4 17.28.27 TUES 30 MAY, 1978 JOB-ABC11XP, ...USBR DISSPLA VER 5.3
GROUND PROFILE FOR SECTION 576
ELEVATION
100.0
98.0
96.0
94.0
92.0
90.0
88.0
86.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
STATION

GROUND PROFILE FOR SECTION 727

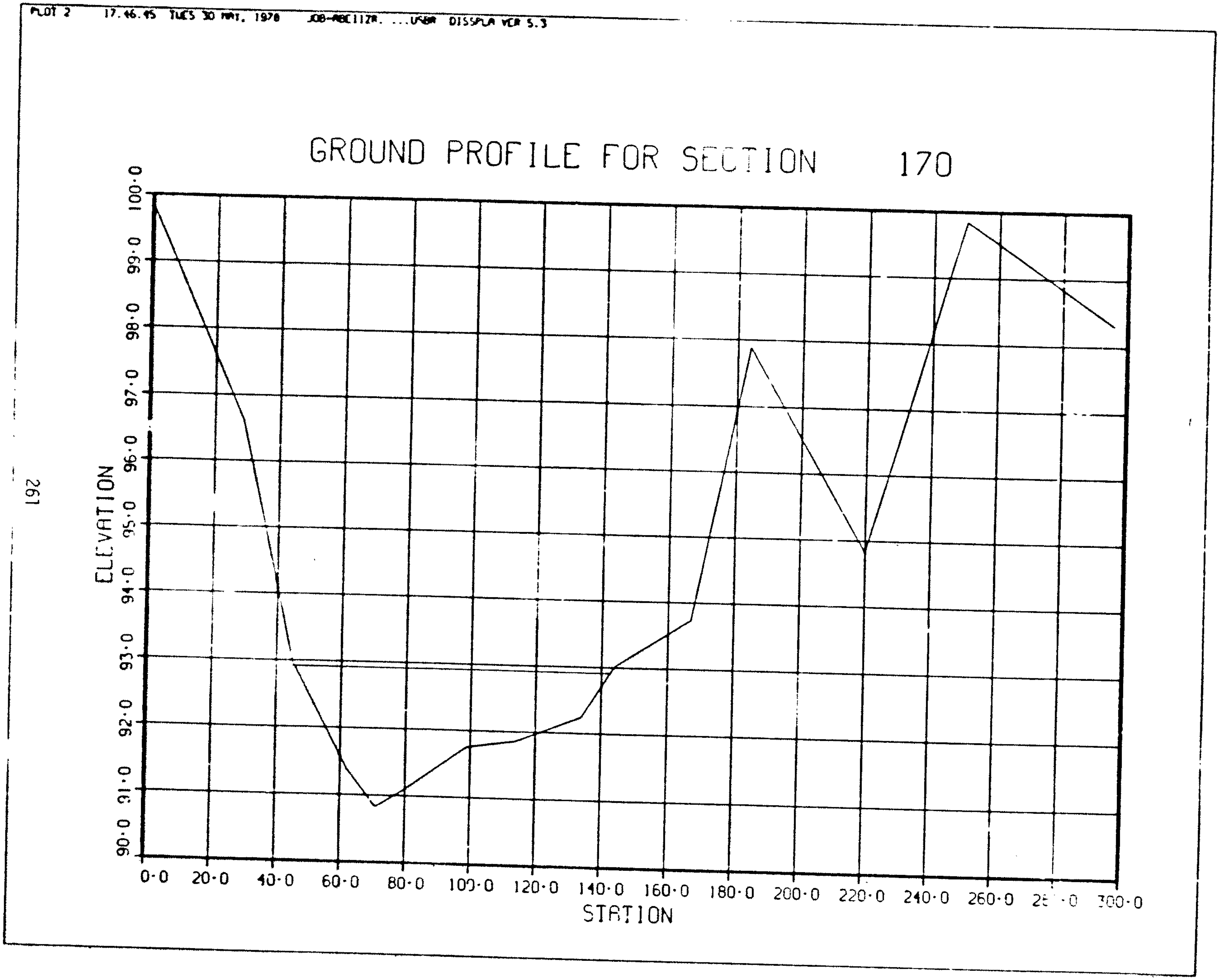


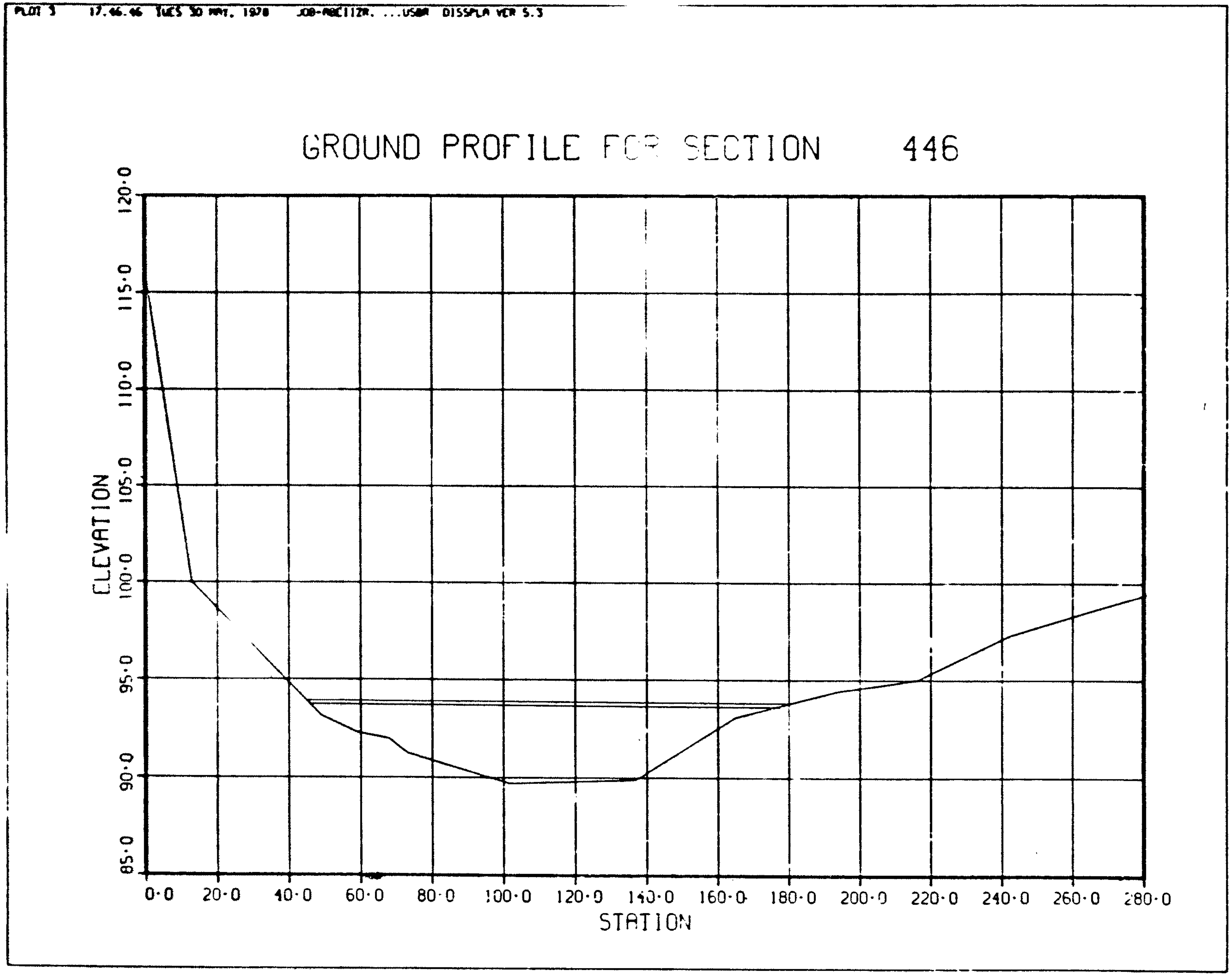
APPENDIX VIIb.

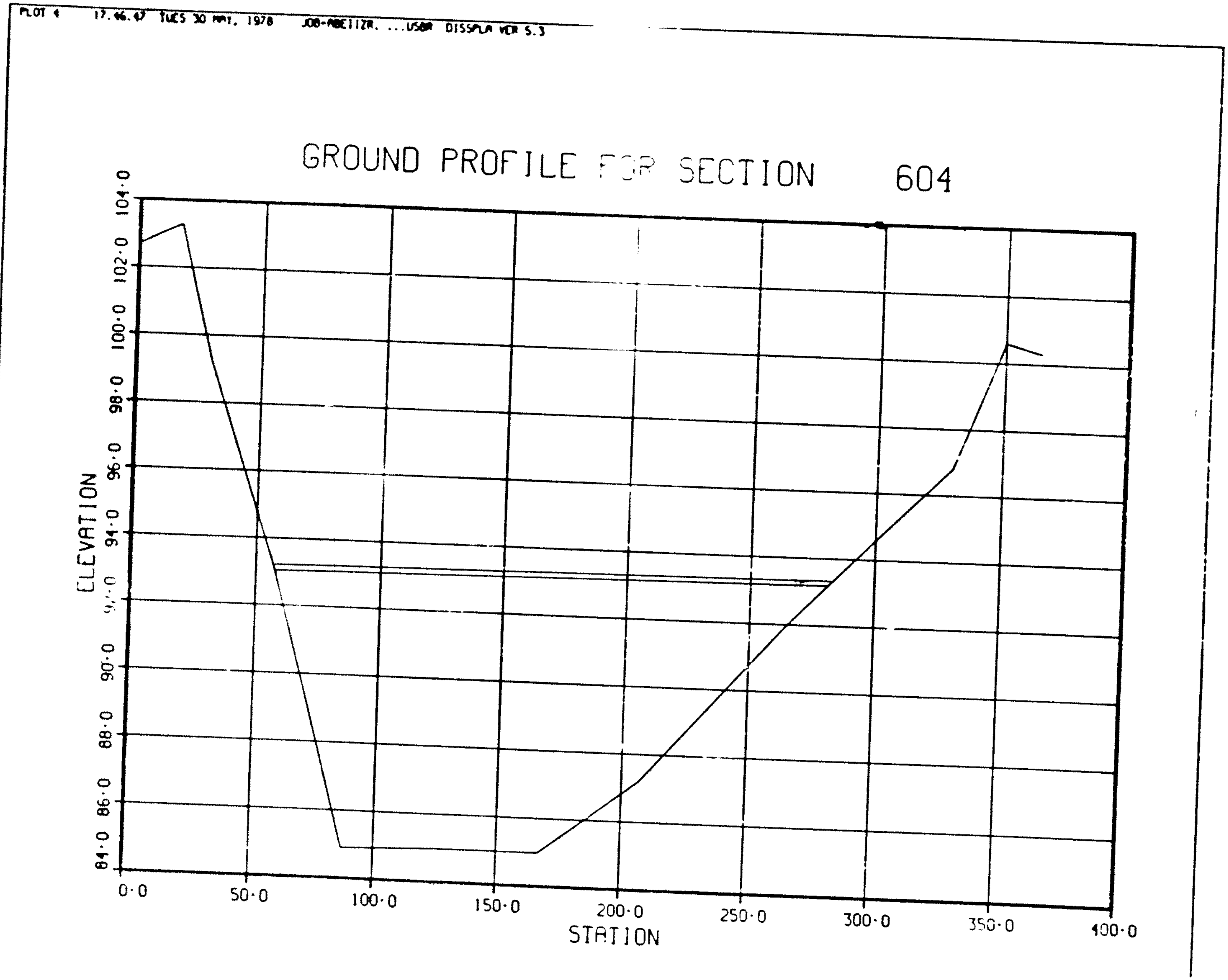
Ground profiles of cross-sections 0-740 at Station Y-4.
Double line indicates water surface elevation at 170 cfs.


GROUND PROFILE FOR SECTION 0
ELEVATION
125.0
120.0
115.0
110.0
100.0
95.0
90.0
STATION
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
260.0

260


PLOT 2 17.46.05 TUES 30 MAY, 1978 JOB-ABC112R. ...USBR DISSPLA VER 5.3
GROUND PROFILE FOR SECTION 170
ELEVATION
100.0
99.0
98.0
97.0
96.0
95.0
94.0
93.0
92.0
91.0
90.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
300.0
STATION

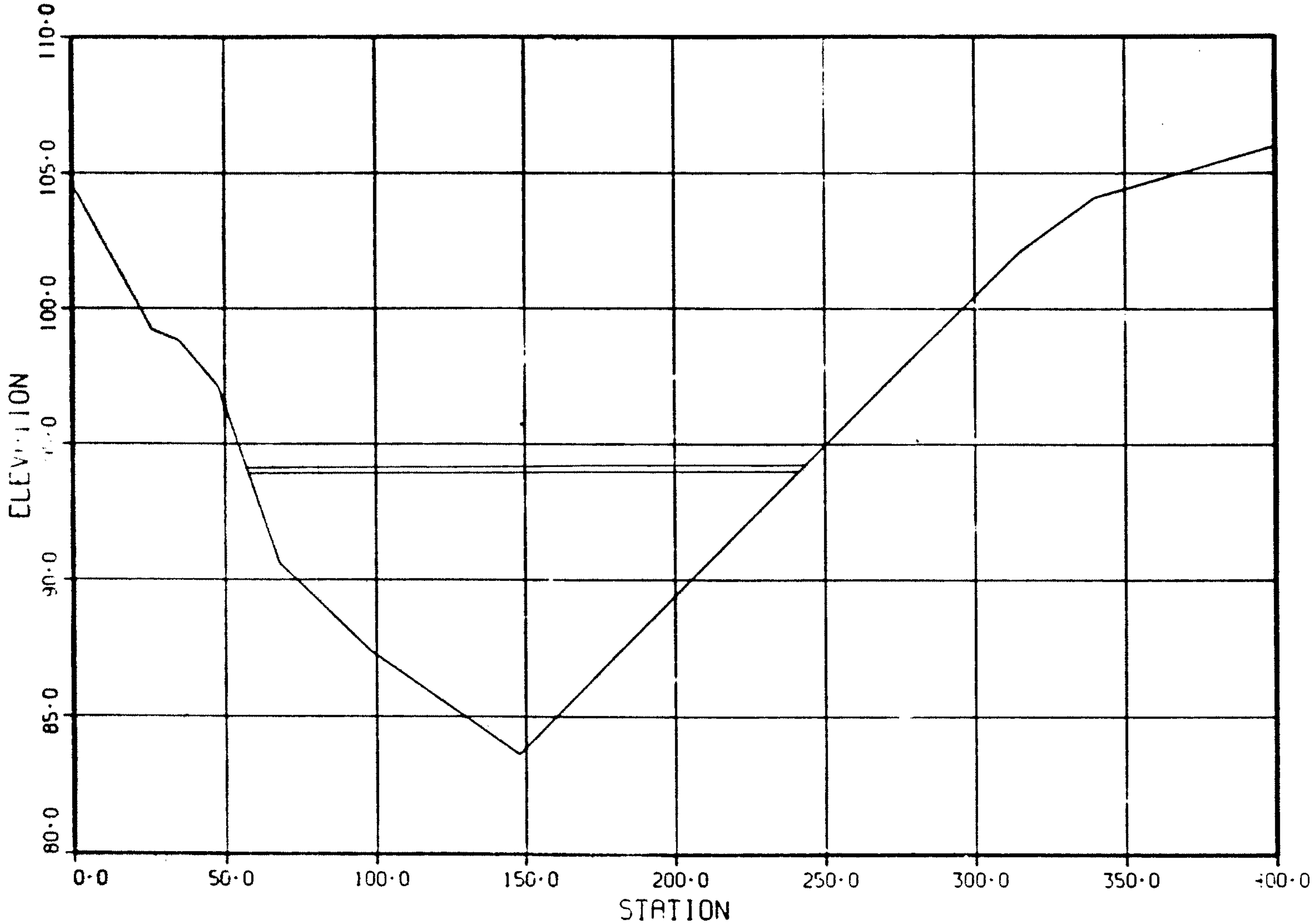

PLOT 3 17.46.46 TUES 30 MAY, 1978 JOB-ABC112R. ...USBR DISSPLA VER 5.3
GROUND PROFILE FOR SECTION 446
ELEVATION
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
STATION


PLOT 4 17.46.47 TUES 30 MAY, 1978 JOB-ABEIIZR, ...USBR DISSPLA VER 5.3
GROUND PROFILE FOR SECTION 604
ELEVATION
104.0
102.0
100.0
98.0
96.0
94.0
90.0
88.0
86.0
84.0
STATION
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0

263

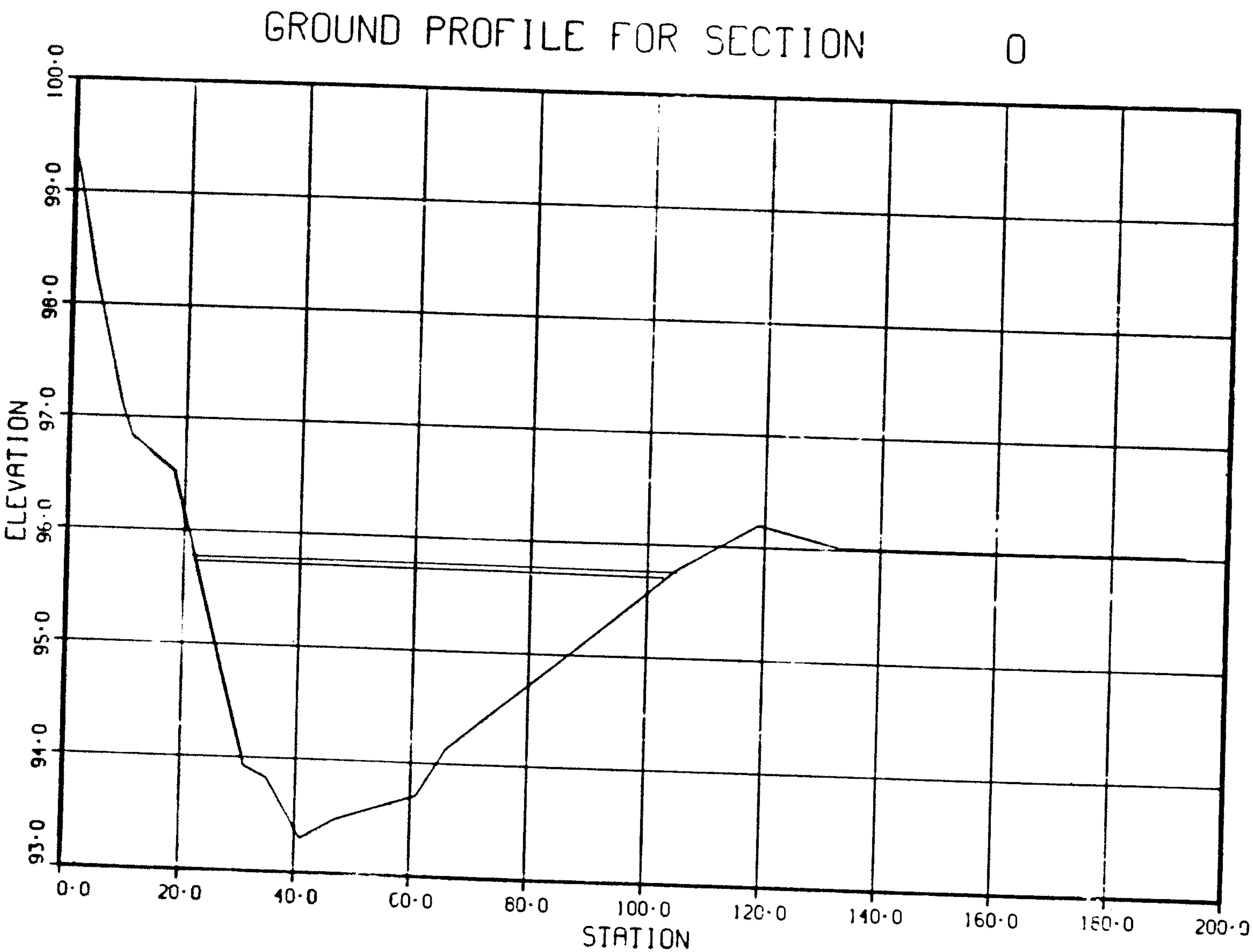
PLOT: 5 17.46.49 TUES 30 MAY, 1978 JOB-AGC:IZR. ...USBR DISSPLA VER 5.3

GROUND PROFILE FOR SECTION 740



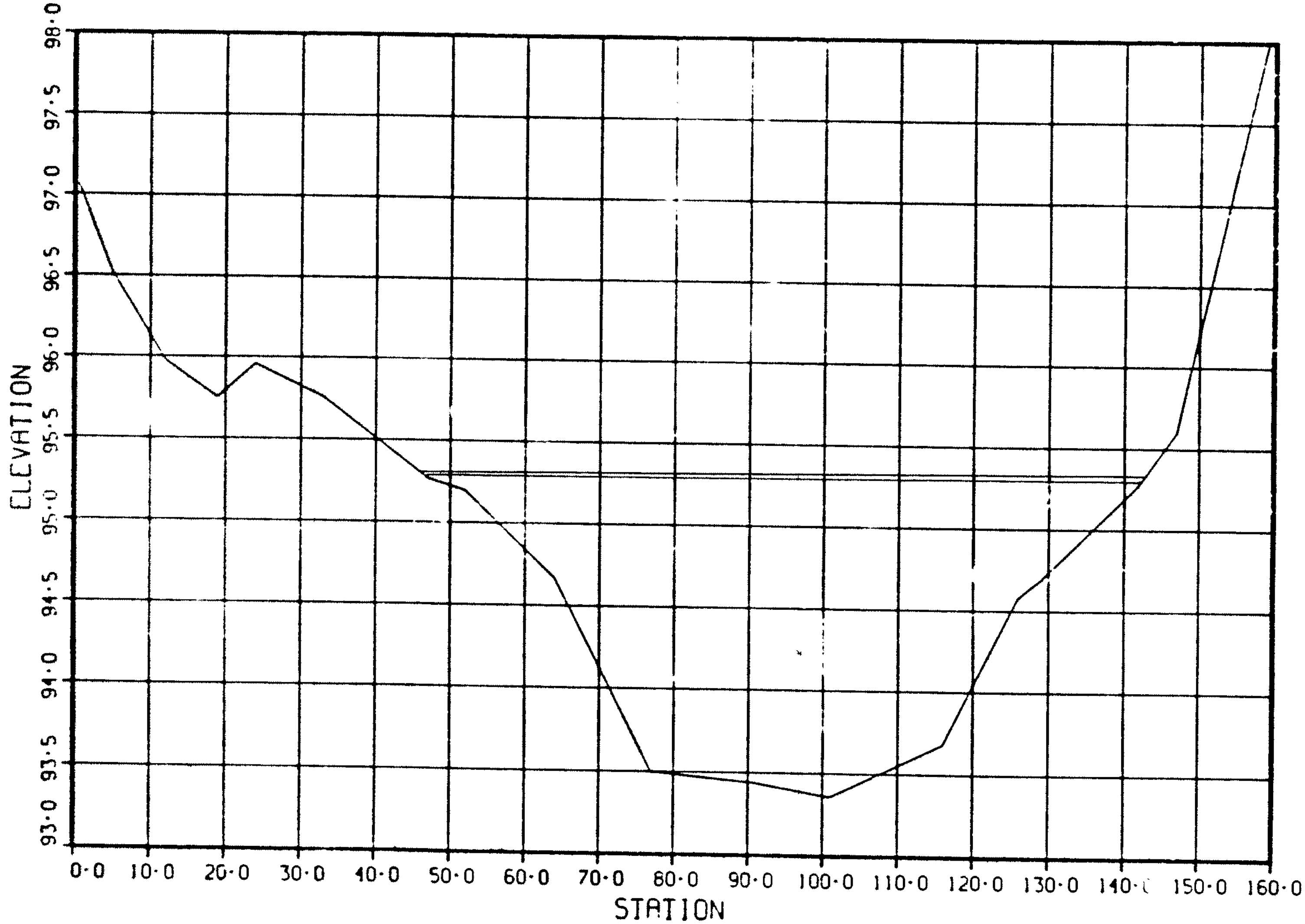
APPENDIX VIIc.

Ground profiles of cross-sections 0-409 at Station W-A. Double line indicates water surface elevation at 210 cfs.

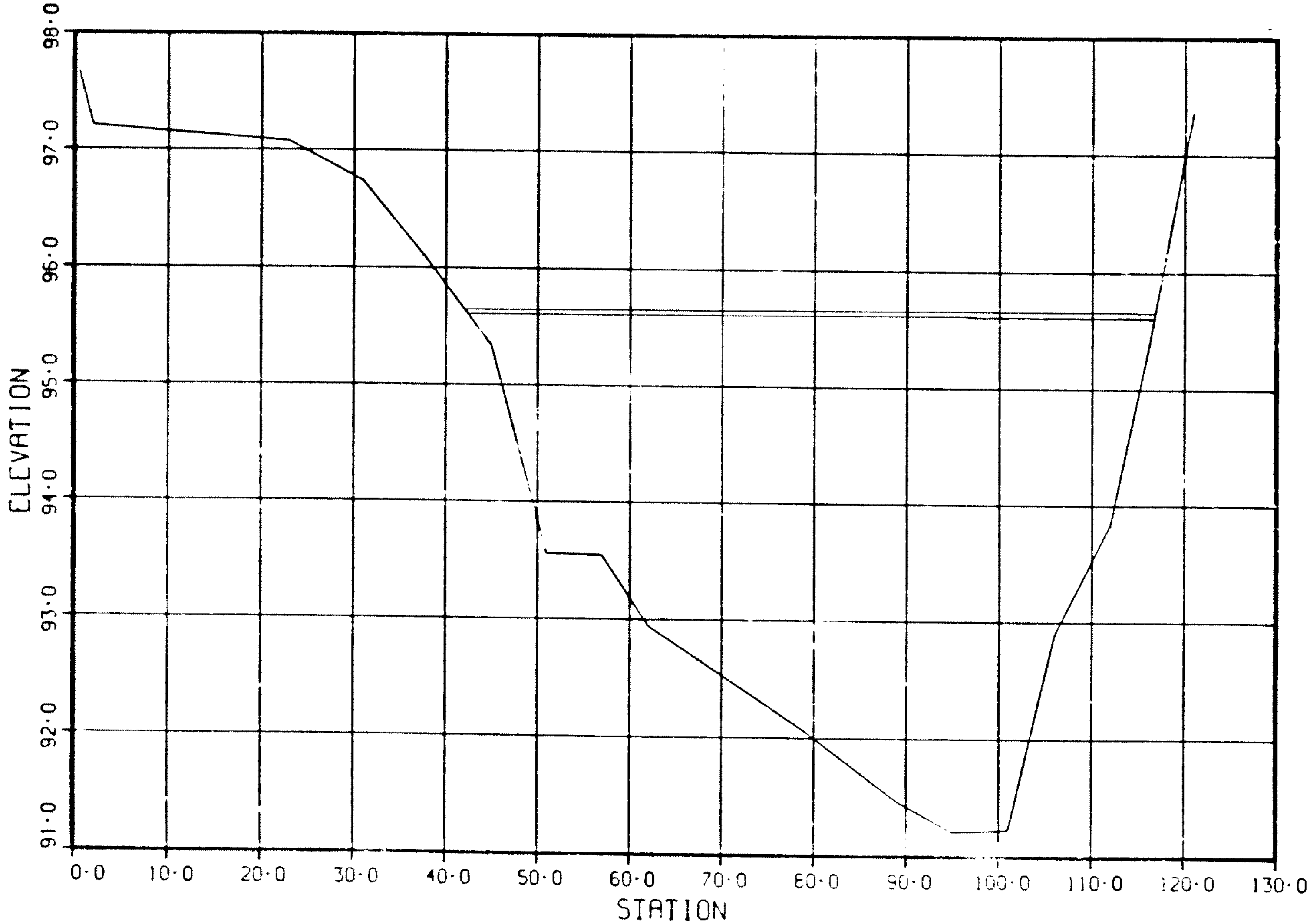

GROUND PROFILE FOR SECTION 0
ELEVATION
100.0
99.0
98.0
97.0
96.0
95.0
94.0
93.0
STATION
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0

PLOT 2 17.34.15 TUES 30 MAY, 1978 JOB-ABC1IIH, ...USBR DISSPLA VER 5.3

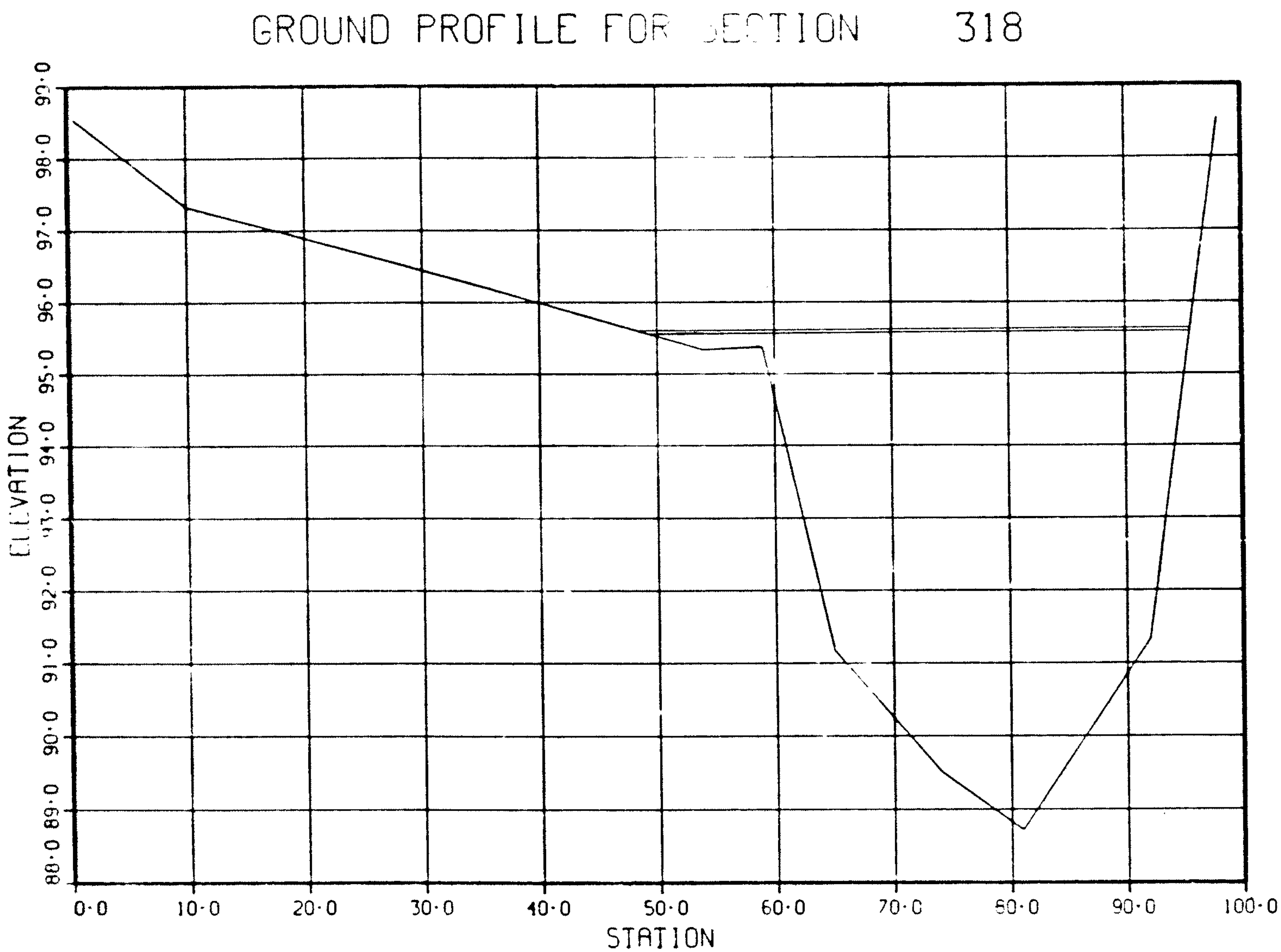
GROUND PROFILE FOR SECTION 75



## GROUND PROFILE FOR SECTION 238

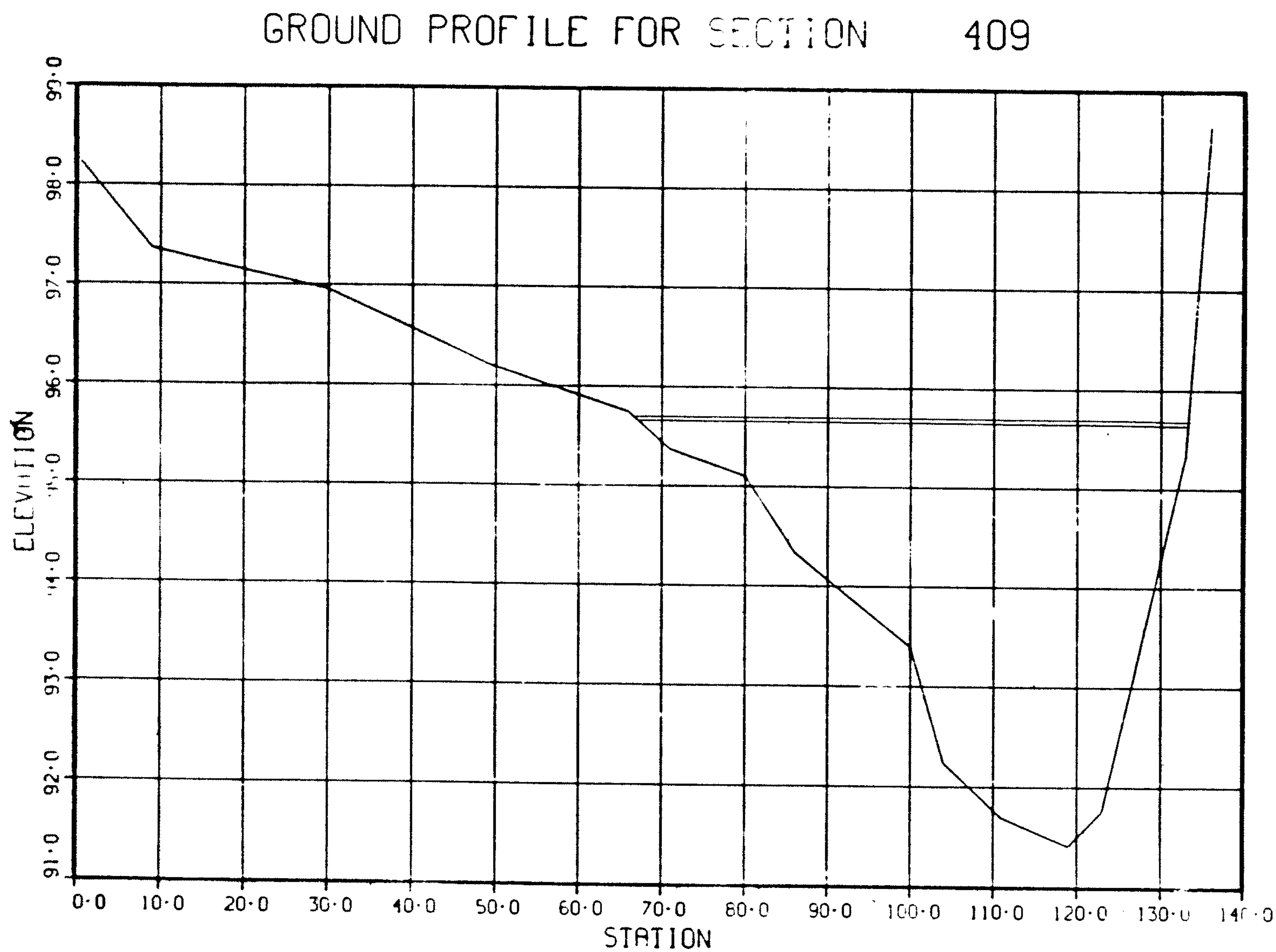


PLOT 4 17.34.20 TUES 30 MAY, 1978 JOB-RBEIITH. ...USBR DISSPLA VER 5.3



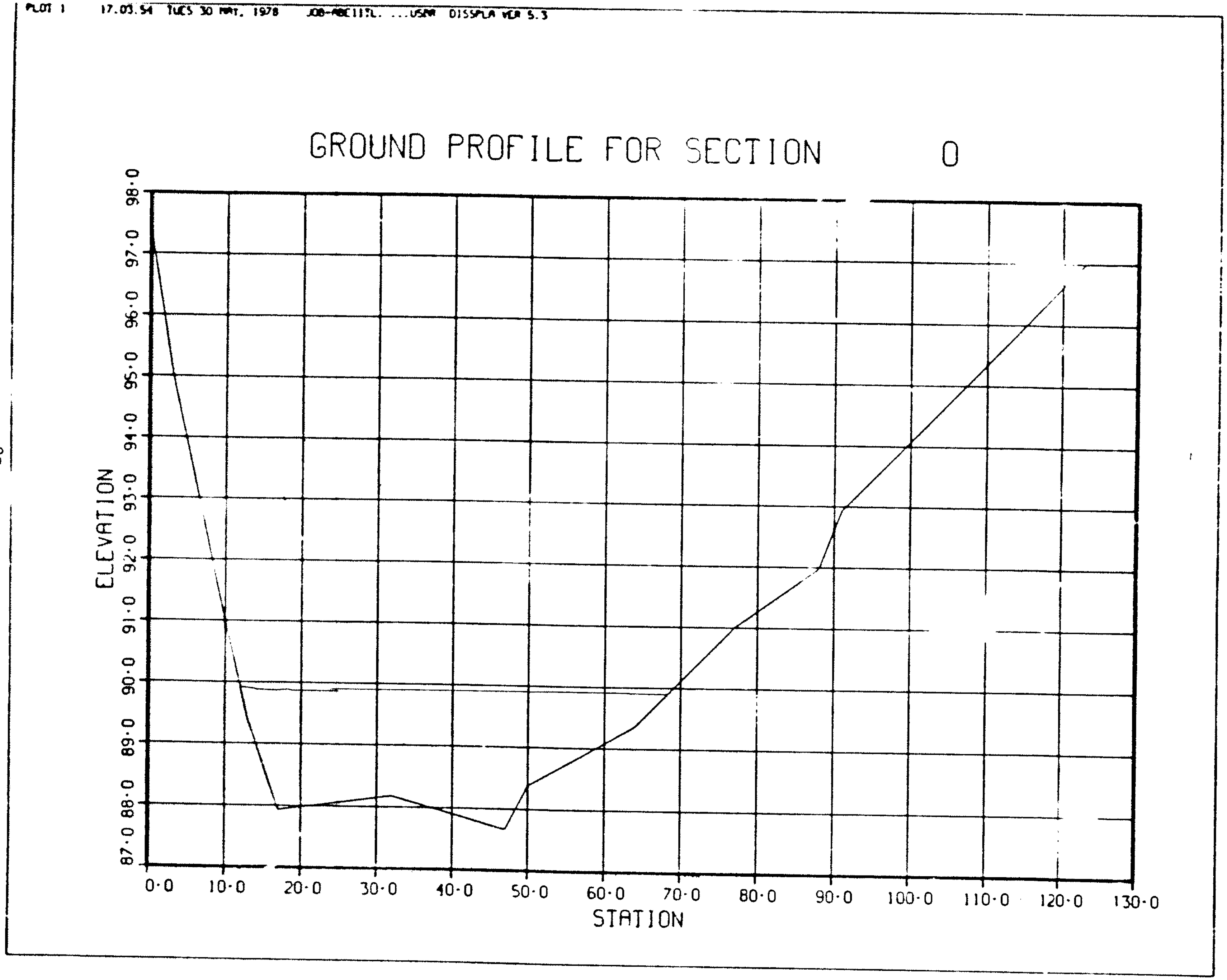
PLOT 5 17.34.21 TUES 30 MAY, 1978 JOB-ABCIIIH, ...USBR DISSPLA VER 5.3

270



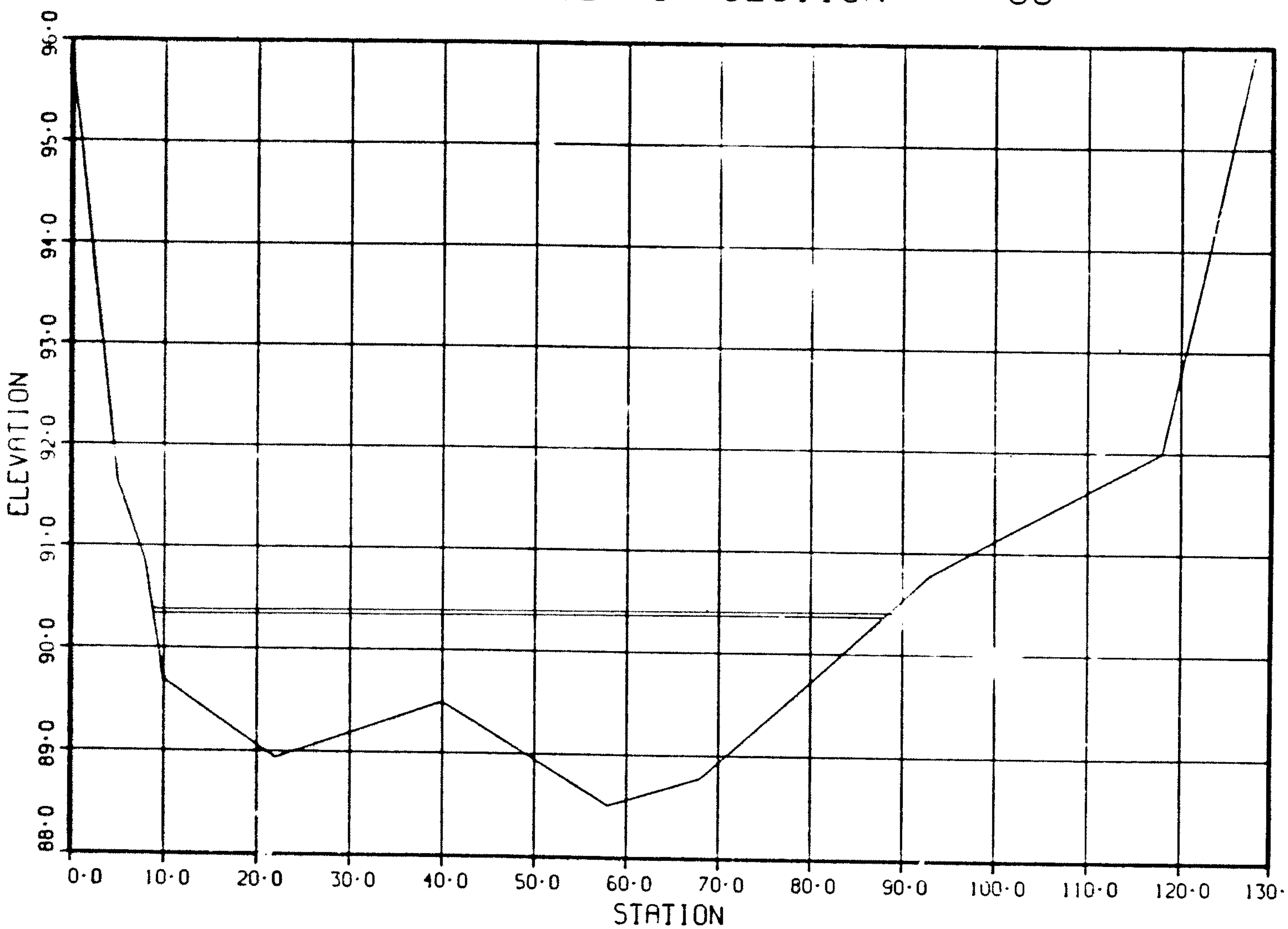
APPENDIX VIId.

Ground profiles of cross-section 0-360 at Station W-B. Double line indicates water surface elevation at 130 cfs.

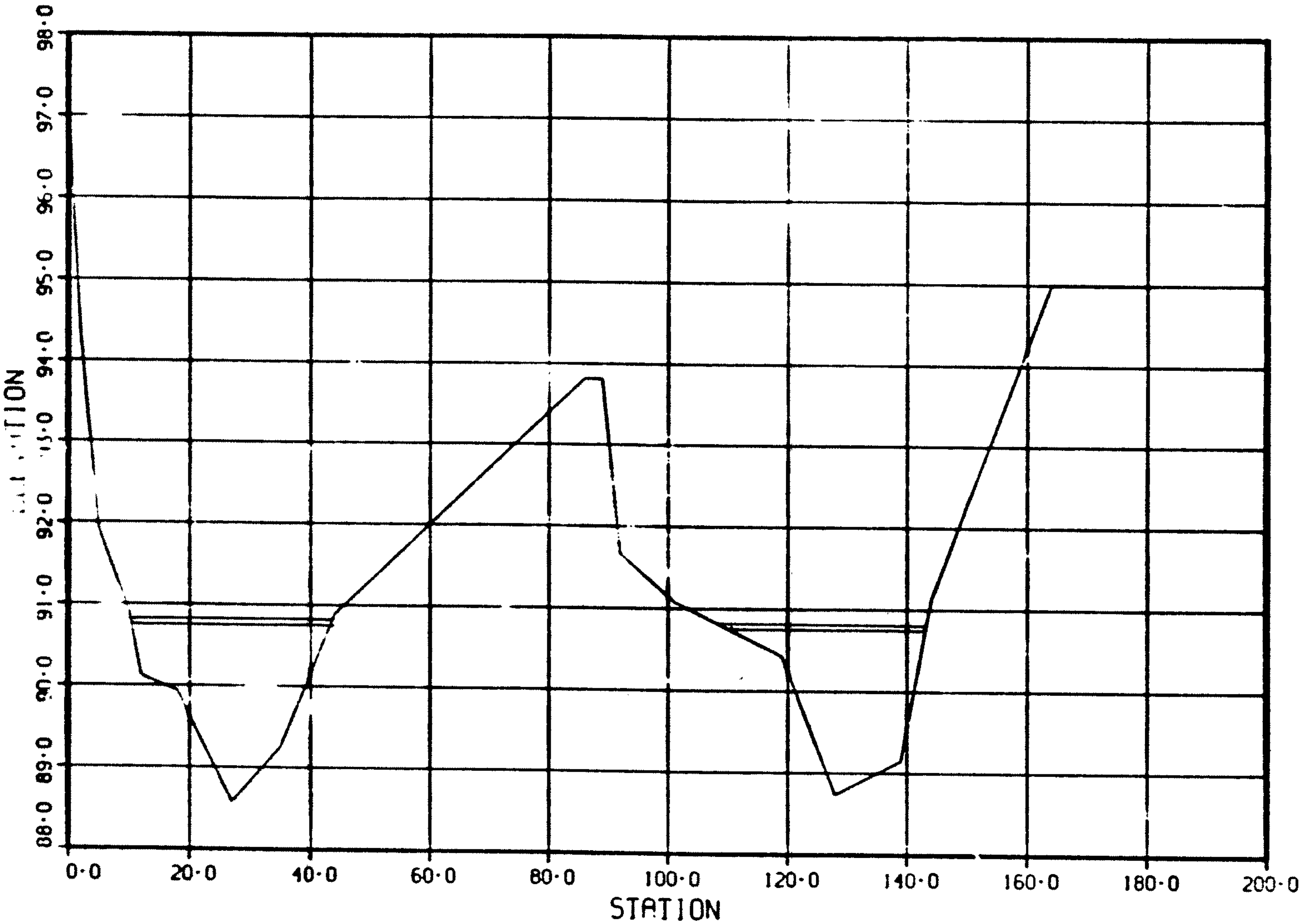

PLOT 1 17.03.54 TUES 30 MAY, 1978 JOB-ABC1ITL. ...USNR DISSPLA VER 5.3
GROUND PROFILE FOR SECTION 0
ELEVATION
98.0
97.0
96.0
95.0
94.0
93.0
92.0
91.0
90.0
89.0
88.0
87.0
STATION
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0

PLOT 2 17.03.56 TUES 30 MAY, 1978 JOB-ABCIITL. ...USBR DISSPLA VER 5.3

# GROUND PROFILE FOR SECTION 80



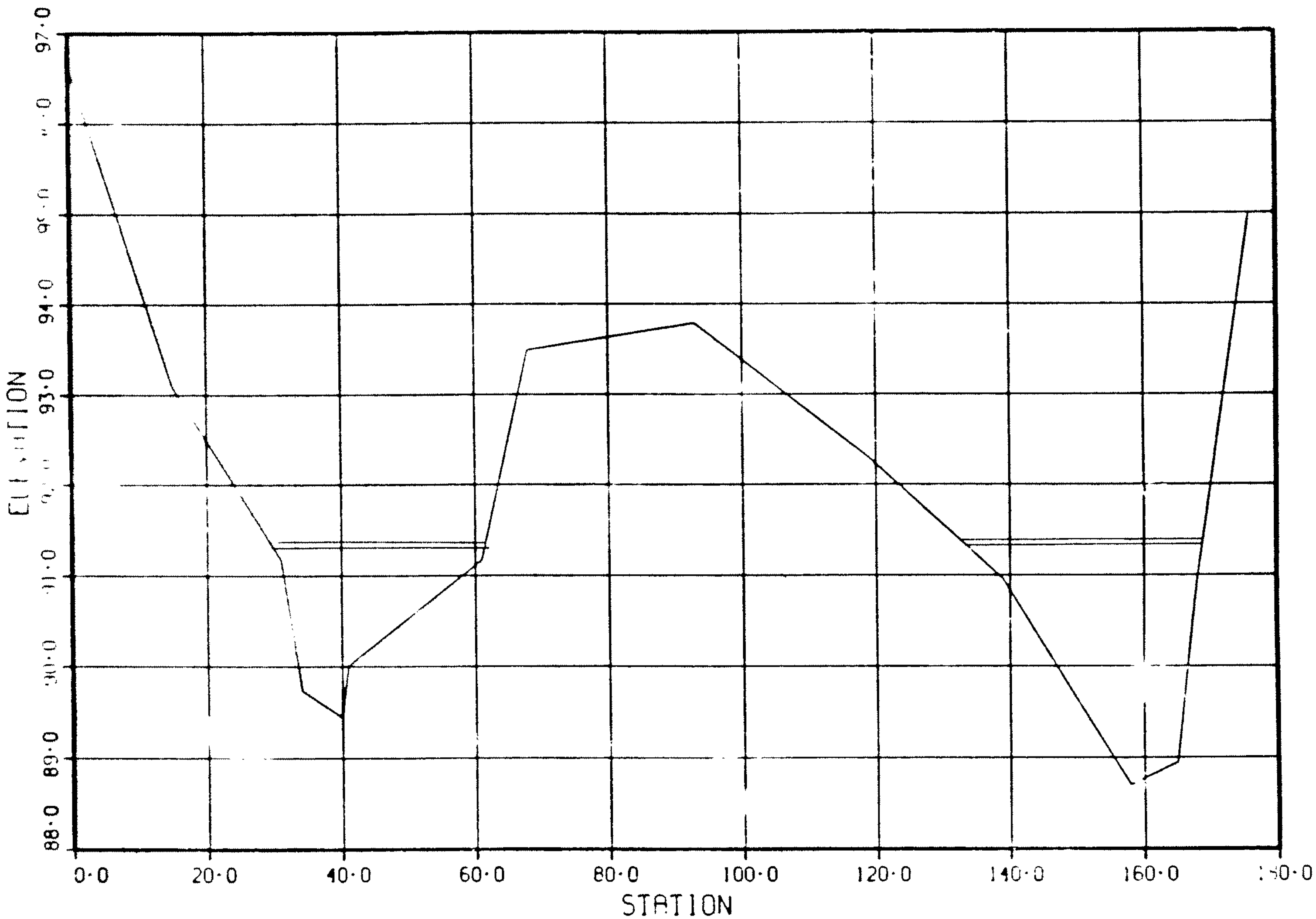
GROUND PROFILE FOR SECTION 166




274

PLOT 4 17.03.59 TUES 30 MAY, 1978 JOB-ABC111L. ...USBR DISSPLA VER 5.3

GROUND PROFILE FOR SECTION 261



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